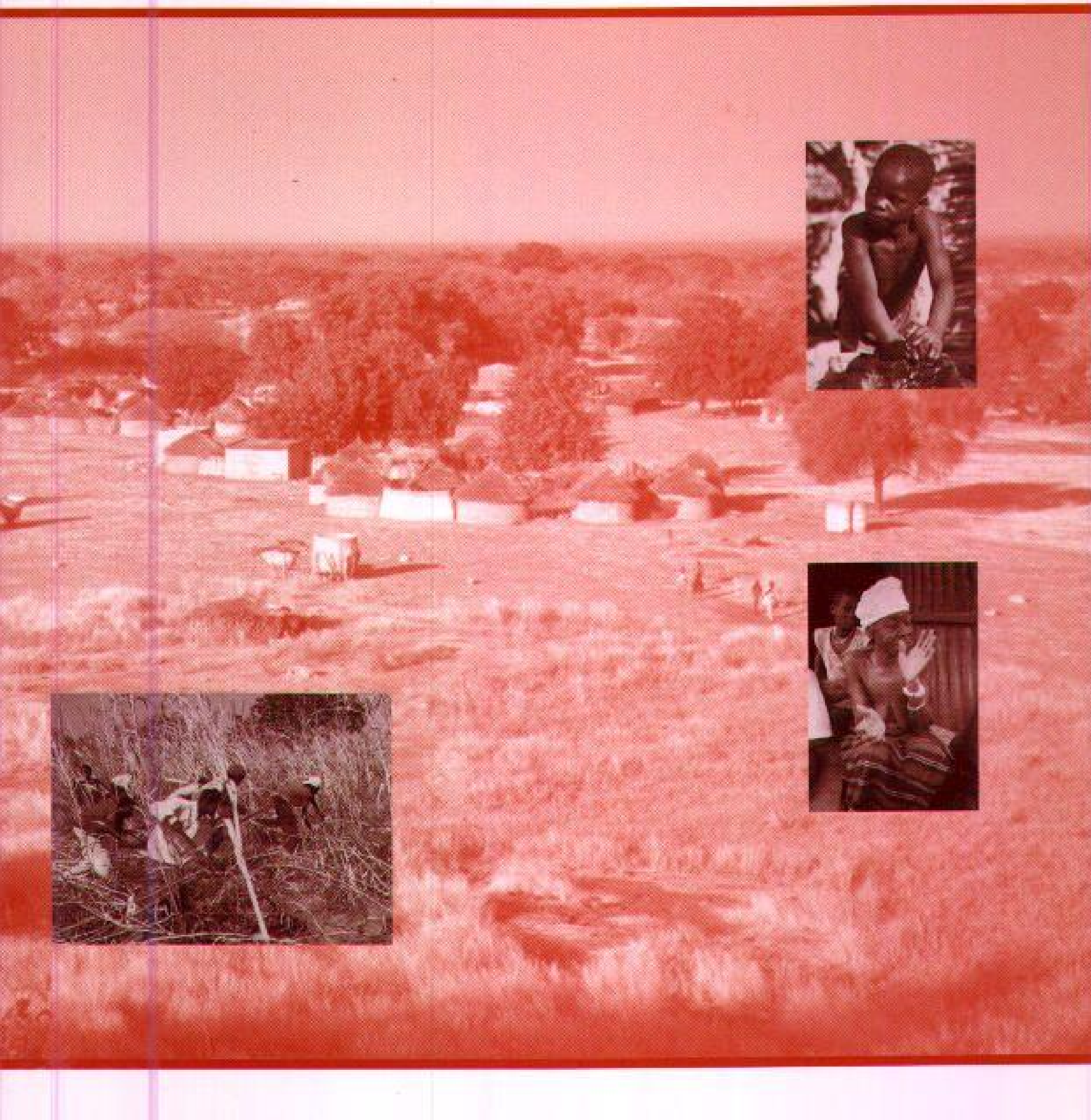
Rethinking soil and water conservation in a changing society

a case study in eastern Burkina Faso

Valentina Mazzucato and David Niemeijer



Propositions

by Valentina Mazzucato

1. Until land degradation debates concerning Africa move beyond the focus on population density and the presumed necessity of agrarian capitalism, the dynamics at play in African landscapes cannot be understood. (this study)

2. Social networks provide a flexibility in dealing with the variable Sudano-Sahelian social and natural environments that is not met by soil and water conservation measures that are currently being extended to African farmers. (this study)

3. Flexibility is not an inherent quality of social networks. Rather, it is the result of people adapting the uses and composition of social networks to deal with changes in their physical, social, and economic environments. (this study)

4. A lack of evidence of land degradation may not only be an indication that enough resources and appropriate technologies are *available* to cultivate in an environmentally sustainable way, but also that people are able to *access* those resources and technologies. (this study)

5. To understand the different forms that intensification of African agriculture can take, it is necessary to study the multiple ways institutions develop rather than presume a certain direction of institutional development. (this study)

6. Interdisciplinary research is not only about transgressing disciplinary boundaries, but also about letting go of one's sense of "proprietorship" over information collected. (this study)

7. A gift that does nothing to establish a relationship between the giver and receiver, is as good as no gift at all. (this study)

8. One reason for misunderstandings between villagers and development agencies is the misconception on the part of agencies that aid can be given as a one-time transaction in which the giver and receiver are free from a binding relationship.

9. Understanding the cultural economy of migrant communities is essential for moving the debate about multiculturalism in Europe beyond the simplistic solutions of assimilation or segregation.

10. Giving birth in one's own home is an experience that can help create a communicative relationship between two women living in localities with cultures and technology regimes as diverse as the Netherlands and eastern Burkina Faso.

11. Knowing what you are looking for is a detriment to creative research.

12. The abolition of the current rating system for scientific publications would be a major contribution to interdisciplinary research.

Propositions with Ph.D. thesis:
Rethinking soil and water conservation in a changing society: A case study in eastern Burkina Faso

Wageningen, 20 June 2000

Propositions

by David Niemeijer

1. Land degradation is so difficult to measure that it is mostly inferred from casual observations or hearsay. (this study)

2. In adjusting their agricultural practices in an environmentally sustainable way, farmers respond to far more pressures and opportunities than population density alone. (this study)

3. Farmers are able to achieve forms of agricultural intensification that, in terms of productivity increase and environmental sustainability, challenge the conventional wisdom of capital-led intensification. (this study)

4. There is an urgent need to develop methods to quantify the effects of African small-holder farm management. Only in this way can farmer practices finally compete on equal footing with fully quantified, research-developed technologies. (this study)

5. Famines are an unexpected contributor to agricultural innovation because, in search for food, farmers obtain new landraces that may perform better than existing landraces. (this study)

6. Given the importance awarded to population and livestock densities in the land degradation debate, it is a sobering fact that for a country such as Burkina Faso the provincial areas – required to calculate population densities – may differ as much as a factor 2.7 between different sources. (this study)

7. Considering the important role of landraces in farmers' strategies for coping with environmental change, it is at the very least worrisome that large corporations, through hybridization, terminator technology, and patenting of plant genetic material, are preventing farmers from maintaining their own seed banks.

8. Considering the way the AIDS epidemic has spread in Africa, it is likely to have a much larger impact on the livelihood of local farmers than agricultural research and development can ever hope to have.

9. The importance of participatory action research is not in the direct results such as improved technologies or land management, but more in the indirect result of increasing respect for farmers among extensionists, researchers, policymakers, and, most of all, among farmers themselves.

10. For effective fieldwork, respecting local governmental and non-governmental organizations and their staff is at least as important as respecting villagers.

11. It often takes less effort to be helpful than to be unhelpful.

12. The more colorful the output of scientific analysis, the more reason to question the quality of the input.

Propositions with Ph.D. thesis:
Rethinking soil and water conservation in a changing society: A case study in eastern Burkina Faso

Wageningen, 20 June 2000

Rethinking soil and water conservation in a changing society

a case study in eastern Burkina Faso

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Rethinking soil and water conservation in a changing society

a case study in eastern Burkina Faso

Valentina Mazzucato and David Niemeijer

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To

Luca, Saskia, Mattia,
Rosa, and Bente

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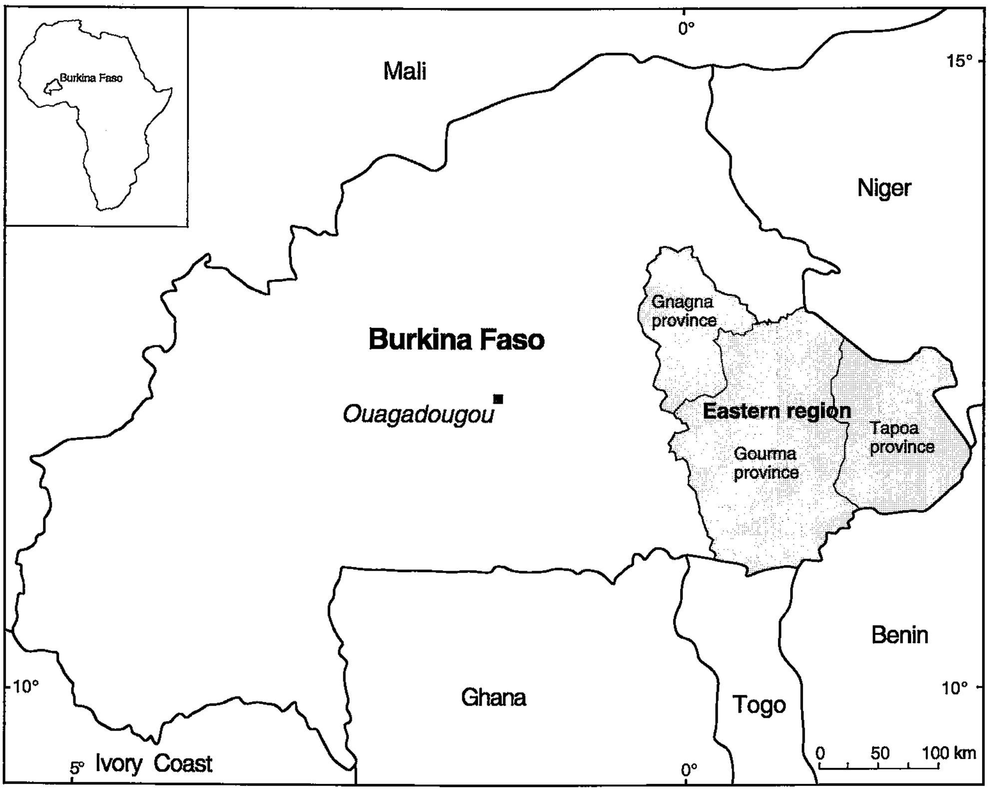
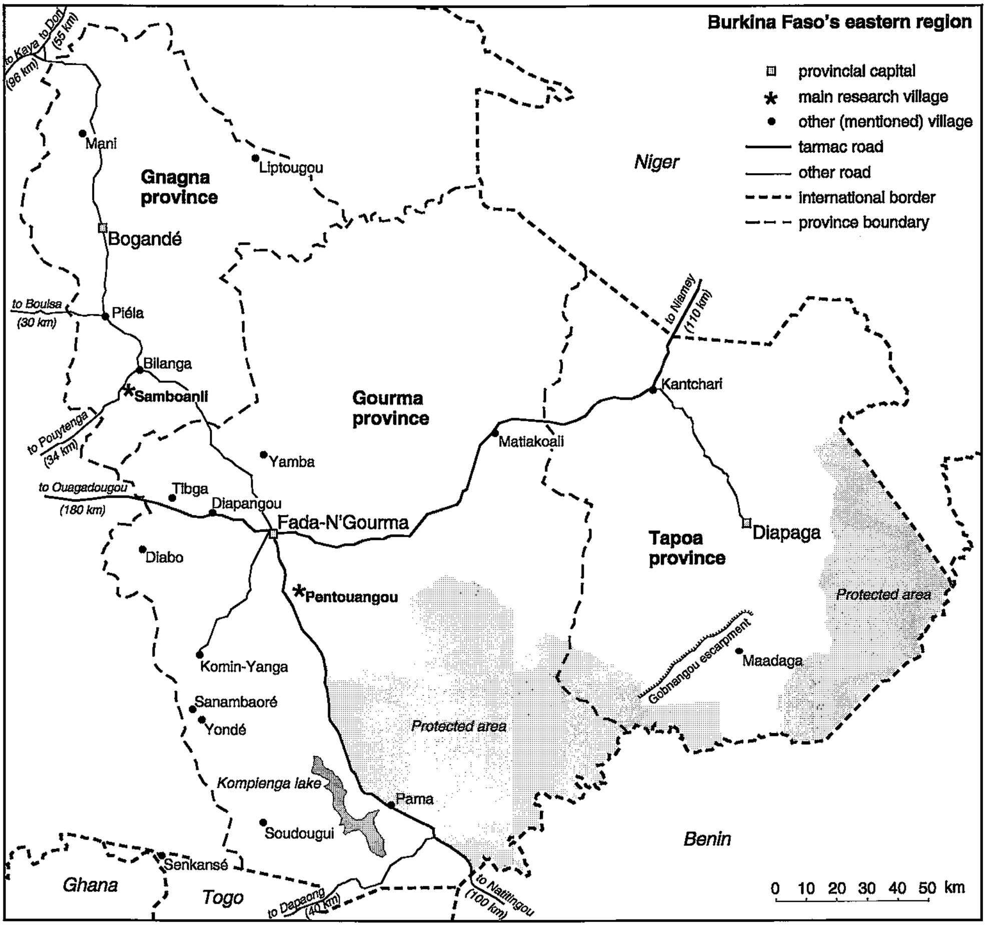
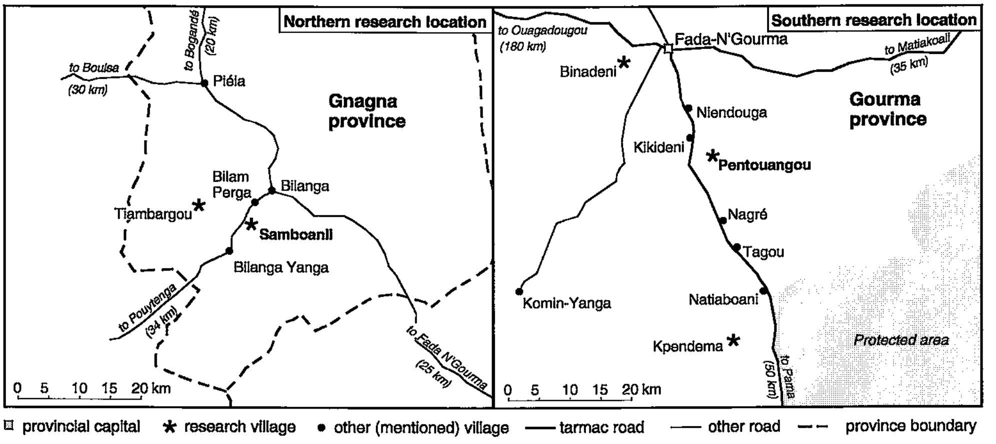


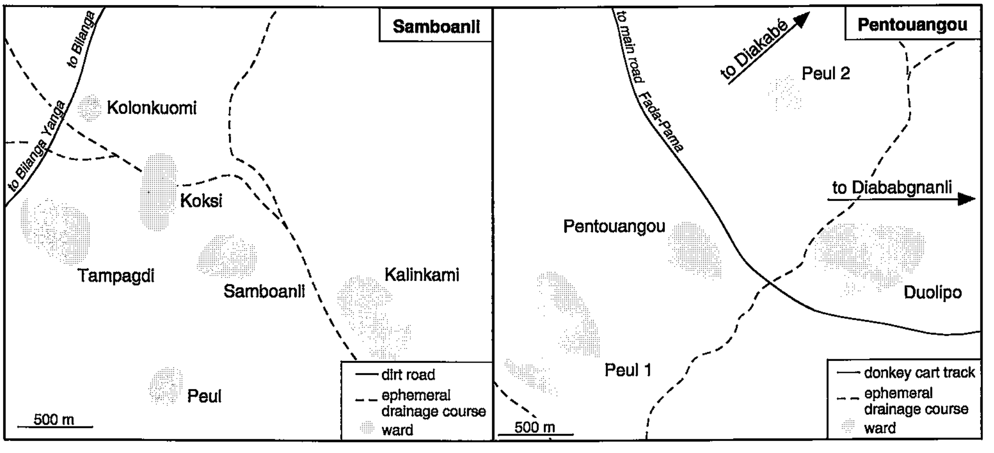
Map 1. Burkina Faso and the eastern region



Map 2. Eastern Burkina Faso



Map 3. Northern and southern research locations, indicating the main and secondary research villages



Map 4. The two main research villages, Samboanli and Pentouangou, and their wards

Preface

When one of us was interviewed for the position to conduct this research, the critique was made that the research proposal was too ambitious: it covered too many aspects and could not realistically be done even in the four years of the contract. The intention of the criticism was to suggest that the proposal be more narrowly focussed. The originator of the proposal, Leo Stroosnijder, instead had another idea. He decided to ask another researcher, from a different discipline, to join the team. This was risky business. Joint doctoral theses are not common, nor do they have a high success rate: stories abound of failed attempts. Neither of us had met before, so Leo invited us for a chat in a café so that we could at least sound each other out before we made the final jump. Both of us ordered tea. In a coffee drinking nation as the Netherlands, this was surely a sign of a certain affinity—so we jumped. This book is the result of that jump.

We began with the idea of writing two separate theses, dividing the work along our disciplinary fields. But it soon became apparent that if this collaboration was to succeed, we needed to let go of the clear delineations of proprietorship. Boundaries needed to become fuzzy so that stepping beyond them was not a transgression but a sign of true integration of the work. This is why this book, the product of this process of letting go, is a truly collaborative effort. Behind the results, even when they are more along one discipline than another, lie endless discussions between the both of us. We were each other's severest critics. Despite this close collaboration, we are, for academic purposes, obliged to attribute some chapters to each author. Singly for this purpose we attribute chapters 5 and 6 to David Niemeijer and 7 and 8 to Valentina Mazzucato.

One of the consequences of working together is that we address a mixed audience. The topic of this book relates to how soil and water conservation should be studied. Through it we are addressing both technical as well as social scientists. This, therefore, reflects in the style of writing. For certain disciplines some sections may seem obvious, while others not detailed enough. For us the objective was to obtain a balance between disciplinary rigor and making the material accessible to people with different disciplinary backgrounds. This is the only way that we felt a dialogue could be initiated between disciplines, in which people are speaking the same language.

Working in this interdisciplinary fashion meant approaching the subject matter from many different angles. The largest consequence of this approach was borne by the villagers who had to endure our ceaseless questioning about all aspects of their lives. Not only did they endure us, but they did so with great warmth and hospitality. To them we owe our deepest gratitude.

Given the at times sensitive material that we present in the book, we have created pseudonyms for villagers about whom we present detailed budgetary information.

However, in the case of interviews in which people's knowledge is communicated, we have purposefully kept their original names so as to acknowledge their contribution to this book.

There are others without whom this book would not have been realized. Our three research assistants Mariama Koudougou, Anatole Thiombiano, and Alain Lompo, tirelessly followed our work schedules and through their utmost respect for the villagers of our study, were fundamental in establishing and maintaining a mutual relationship of trust with the villagers. They also were subject to our interdisciplinary approach by having to conduct all sorts of interviews, fill out many different kinds of questionnaires and carry out a whole range of measurements. They were indefatigable and made village visits even in the most averse conditions. They let the villagers enter their private lives in ways that are only known to African hospitality. Salifou Traoré and Dan Lankoandé, who later joined the team also provided excellent help as did François Kiema, Malik Lankoandé, and several others who carried out market surveys and transcribed recorded interviews. Very insightful was the work by Ali Badara Diallo who, during a period of one year, carried out research for us among the livestock herders that also lived in the research villages but who were not part of our principal study population.

In Fada N'Gourma we received the help of various individuals and institutes. Our special thanks go to His Majesty Yuabli who granted us permission to work in his kingdom. Dialoaga Lankoandé and Kanfieni Naini, then working for the APRG, as well as Jules Tandamba, a retired extension agent, all helped us in making the first contacts with the villages and provided ongoing support and insights during the course of our research. We also benefited from the collaboration of various governmental and non-governmental organizations, who shared with us their knowledge and experience of the research area, such at the DRARA de l'Est, DREEF de l'Est, the SPA Gourma and Gnagna, the SPRA Gourma and Gnagna, the APRG, the CRRA de l'Est, Tin Tua, the Préfectures of Bilanga and Fada N'Gourma and the Haute Commissariat in Fada N'Gourma. Eleanor Smithies, a long-time resident of Fada N'Gourma introduced us to key persons and contributed to making our stays in Fada N'Gourma also fun from a social point of view.

In Ouagadougou we benefited from conversations with Dr. Adjima Thiombiano from the University of Ouagadougou who helped with identifying the scientific names of Gourmantché plant species; Jan Piet van der Mijl with whom we discussed the way agricultural statistics are compiled in Burkina Faso in general and by the ENSA project in particular; the director of the National Archives, the director of the CNRST, and Amadou Diallo, all of whom helped us to access colonial archival documents; Dr. Georges Madiéga with whom we discussed Gourmantché history.

This research was part of a collaborative project between Wageningen University and the University of Ouagadougou in which various research projects are conducted on the topic of agro-silvo-pastoral land use in the Sahel. The staff from the Antenne Sahélienne in Ouagadougou, the joint outreach station of this project, has helped us greatly. Our thanks go in specific to Jan Willem Nibbering, Maja Slingerland, Joop Begeman, Paul Kiepe, and Teunis van Rheenen who handled some of the practical aspects of our stays and also provided scientific backstopping. Adama Belemviré, Abdoulaye Mando, Rose Nikiéma, Moumini Savadogo, and Roger Kaboré, all helped in providing information and data that we had not been able to collect during our short stays in Ouagadougou. Antoine, Bala, and Marie-Louise helped handle many practical aspects of the research.

Two people supervised this research and tirelessly read multiple versions of each chapter. We want to thank our professors Leo Stroosnijder and Niels Röling not only for their insightful comments, but also for the faith they have always showed in this "experiment", and for encouraging us to go our own ways even if at times it seemed like we were departing rather radically from the subject matter. They also gave us the freedom to work in a truly interdisciplinary manner by not forcing their disciplinary backgrounds onto this work. Their collaborative spirit created an ideal work environment.

We supervised students from several Dutch universities, who helped us out in the field. Karin Wolffenbuttel, Reinder Zuurd, Heidie Lutgendorff, Patricia Bannier, Mariken Gaanderse, and Linda Boele contributed to our work in various ways, ranging from organizing and studying dusty colonial archives to fieldwork under the scorching sun.

During the course of this study we have exchanged ideas with many individuals. Our gratitude goes to all of them, but we would in particular like to mention some of the people who commented on various works in progress such as the late Mike Warren in the United States, Jean-Yves Marchal, Georges Dupré, and Chantal Blanc-Pamard in France, Anette Reenberg, Lars Krogh, Simon Bolwig, and Bjarke Paarup-Laursen in Denmark, and Polly Hill, Melissa Leach, and James Fairhead in the UK. Also at home we benefited from comments and discussions with various people: Ton Dietz, Leo de Haan, Willem Veerman, Chris Reij, Tjeerd Jan Stomph, Nico de Ridder, Paul Richards, Shanti George, Freerk Wiersum, Mark Breusers, and our colleagues at the Erosion and Soil and Water Conservation Group in Wageningen. A particular thanks go to two of our family members, Rudo Niemeijer and Luca Bertolini who read our work endless times and provided insightful comments and creative solutions for our research.

Librarians are the silent contributors to studies such as this. We would like to thank the librarians at the FAO, Library of Congress, CIKARD, Aix-en-Provence archives, IRD Paris and Bondy, and, in particular, Rob van Genderen of Wageningen University who not only responded promptly to all our queries, but also was always on the lookout for sources of interest to us.

Our translators also deserve a special thanks. We are particularly grateful to Fabienne Cassagne and Rivka Peyra who took the time to translate the summary and abstract, respectively, into French. Rudo and Leidie Niemeijer, Rosa and Bernd Lehmann, and Terese de Koning, through their perceptive comments, helped make the Dutch summary more readable.

Producing this book was not only an academic exercise but also involved all sorts of other aspects. In Fada N'Gourma we raised chickens (that kept dying), and sheep (that consumed more than they were worth), and had a little home garden where everything except basil and mint died because the soil was too compact and the eucalyptus tree too close. Ali Niampa, our night guard, took good care of the basil seeds so that every time we returned to Fada there would be an expanding basil plantation waiting for us. Fortunately our cook and homemaker Yombo Dahani knew how to put the basil to good use. They were both fundamental in giving us advice based on local interpretations of our behavior such as that we should stop trying to raise chickens because we did not have the right "heads" (vous n'avez pas la tête).

Last but not least, we would like to thank our families. Our parents, Alessandra and Ernesto Mazzucato and Leidie and Rudo Niemeijer, communicated to us a curiosity for people and things near and far, which is also at the source of this book. Our gratitude to our respective partners, Luca and Rosa, is beyond words for their support, love, and patience all along this process. Saskia, who at six months accompanied us on our fieldwork, was a godsend for helping us establish a rapport with villagers and the Fada community (although the organization of our household was a bewilderment to them all: a man and a woman living together, not married, with a child, and each with another man and woman back in their own country). A key player in making this research possible was Delali Ekoué Djenou in whose loving care we would leave Saskia for days at a time to work in the villages. Delali's laugh and Saskia's vitality filled our house with joy. Mattia and Bente, both of whom joined our lives during the last two years of this project should be thanked for their patience because they had to put up with the final phases of the work in which our schedules became unbearably long and tight. Luca, Saskia, Mattia, Rosa, and Bente, to you we dedicate this book.

Acronyms

ADDS	Africa Data Dissemination Service
AEEBF	Association des Églises Évangélique du Burkina Faso
APP	Association Pour la Productivité (later renamed to APRG)
APRG	Association d'Appui et de Promotion Rural du Gulmu
ARFA	Association pour la Recherche et la Formation en Agro-ecologie
ATT	Association Tin Tua
BDPA	Bureau pour le Développement de la Production Agricole
CCD	Convention to Combat Desertification
CR	Collectivités Rurales
CRPA	Centre Régional de Promotion Agro-pastorale
CRRA	Centre Régional de Recherche Agricoles
DRARA	Direction Régionale de l'Agriculture et des Ressources Animales
DREEF	Direction Régional de l'Environnement et des Eaux et Forêts
DRET	Direction Régional de l'Environnement et du Tourisme
DSA	Direction des Services Agricoles, Ministère de l'Agriculture de la Haute-Volta
DSAP	Direction des Statistiques Agro-Pastorales, Ministère de l'Agriculture et des Ressources Animales
ENSA	Enquête Nationale de Statistiques Agricoles
FAO	Food and Agriculture Organization of the United Nations
fcfa	Franc de la Communauté Financière Africaine (US$ 1 was roughly equivalent to 530 fcfa[1])
FDR	Fonds de Développement Rural
FIDES	Fonds d'Investissement pour les Dépenses d'Intérêt Économique et Social
FSR	Farming Systems Research
GDP	Gross Domestic Product
GERES-VOLTA	Groupement Européen de Restauration des Sols en Haute-Volta
GLASOD	Global Assessment of Human-Induced Soil Degradation
GLM	General Linear Model
GNP	Gross National Product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
INERA	Institut d'Études et de Recherches Agricoles
INSD	Institut National de la Statistique et de la Démographie

[1] All currency values are given in current fcfa.

INSEE	Institut National de la Statistique et des Études Économique
IRD	Institut de recherche pour le développement (formerly ORSTOM)
LEISA	Low External Input Sustainable Agriculture
MAE	Ministère de l'Agriculture et de l'Élevage
MARA	Ministère de l'Agriculture et des Ressources Animales
MDR	Ministère du Développement Rural
MEE	Ministère de l'Environnement et de l'Eau
MFP	Ministère des Finances et du Plan
MET	Ministère de l'Environnement et du Tourisme
NGO	Non-Governmental Organization
NIE	New Institutional Economics
ORD	Organismes Régional de Développement
PAG	Programme d'Alphabétisation au Gulmu
PDR	Projet de Développement Rural
PEDI	Programmation et Exécution du Développement Intégré
PNFV	Programme National de Foresterie villageoise
PNGT	Programme National de Gestion des Terroirs
PNLCD	Plan National de Lutte Contre la Désertification
SIP	Sociétés Indigènes de Prévoyance
SMPR	Sociétés Mutuelle de Protection Rurale
SOFITEX	Société Burkinabè des Fibres Textiles
SOM	soil organic matter
SPA	Service Provincial de l'Agriculture
SPRA	Service Provincial des Ressources Animales
SWC	soil and water conservation
UNEP	United Nations Environmental Program
USAID	United States Agency for International Development
USLE	Universal Soil Loss Equation

Introduction

> All terrestrial life ultimately depends on soil and water. (Hillel 1992: 3)

In February 1998, during the Africa Cup held in Burkina Faso, the Dutch coach of one of the African soccer teams remarked to a journalist that there was little to do in the capital Ouagadougou: you could not play golf and outside town it was just a desert.[1] In other words, he conjured up the image that prevails in the media and in policy debates about the Sahel: desolate place void of all luxuries, sand dunes covering the last lonely tree stumps, in the distance some poor fellows trying to make their living with a few meager goats chewing the last shriveled blades of grass emerging from a parched, cracked soil. Had he been there during the particularly wet 1994 rainy season, he would have probably complained about the heavy tropical showers, the three meter high cereal stalks impeding the view of the lush green landscape and the flooded, muddy soils preventing any excursions without rubber boots and a four-wheel drive vehicle.

Burkina Faso, like the other Sahelian countries, is a land of contrasts. Still, the image evoked by the soccer coach dominates the popular discourse. A view that is as much refuted by the facts as the lack of a golf course in Ouagadougou: there is a full 18 hole golf course just a few kilometers south of town. There are more trees in the landscape surrounding Ouagadougou than in many equally densely cultivated areas of say France or the United States. The fact that every year between December and May the grasses are yellow and the harvested fields are barren and that every so many years a drought occurs has led many outside observers to take basically temporary phenomena as indicators of an encroaching desert or signs of irreversible land degradation (Stroosnijder 1992).

As Swift (1996) explains, a desertification narrative developed as early as the 1930s, stimulated by reports such as those from Stebbing, a British forester, on the progressive drying out of the Sahelian area. While other scientists later pointed out that the vegetation followed the rhythm of dry and wet periods and that savanna vegetation should not be assumed to be degraded forest, a seed had been sown. A seed that germinated on particularly fertile ground, as already in the 1920s in French West Africa and in the 1930s in the British colonies, concern had grown over what were considered the detrimental African land use practices (Swift 1996). Initially, the interest of colonial administrators in African husbandry practices stemmed from their desire to increase agricultural production to augment colonial revenue. As Anderson (1984) points out, in East Africa the concern with the "harmful" African practices soon became partly politically motivated in that settler farmers needed an excuse for curtailing land claims of the local population in a period when

[1] NRC Handelsblad, 27 February 1998, page 10.

the colonial enterprises were struck by the Depression of the early 1930s. There was however also a genuine concern that was fostered by the reports of the North American "Dust Bowl" experience that reached Africa in that same period (Anderson 1984). Since then, the concern with desertification and land degradation has dominated the discussion on African land use systems on and off, as drier and wetter periods alternated. The droughts in the Sahelian and Sudanian belt of the early 1970s, the mid 1980s and the early 1990s and the strong population growth after independence have brought the issue to the fore of the development agenda (e.g., Cleaver and Schreiber 1994; Biot *et al.* 1995; CCD 1997; Scoones and Toulmin 1999). UNEP (1997: table 2.2) for instance holds that more than one-fourth of the Sahel is affected by human-induced soil degradation,[2] while Ayoub (1998: 461) reports that "the Sudano-Sahelian region of Africa and some other drylands of the world are experiencing, since the late 1960's, a comparable or even worse environmental disaster [than] occurred in the 'Dust Bowl' in the 1930's in the semi-arid region of the United States."

The way land degradation[3] has been perceived is intimately linked to the history of soil and water conservation interventions in Africa. This is because soil and water conservation technologies, together with an increased and proper use of mineral fertilizer (e.g., Breman 1998), are seen as the major solution to the perceived inappropriate agricultural practices leading to land degradation. As such they also provide a solution for raising agricultural production to keep pace with Africa's rapidly growing population. Concern for these issues has been an important motivation behind soil and water conservation interventions in Africa ever since the 1930s, when the first major conservation efforts took place in the British colonies in eastern and southern Africa (Anderson 1984; Stocking 1985). In French West Africa similar large-scale efforts followed after independence in the 1960s (Reij 1983; Marchal 1986; Vlaar 1992; Scoones *et al.* 1996).

At first, soil and water conservation interventions were primarily focused on erosion control (Scoones *et al.* 1996), while there was also some early interest in water conservation as exemplified, for instance, by colonial water spreading schemes in Kenya (Hogg 1986). Starting in the late 1940s, soil fertility decline, overstocking and deforestation were added to the concerns (Scoones *et al.* 1996). The major African droughts of the early 1970s and mid 1980s however not only rekindled the interest in water conservation, but also fueled the fear of large-scale environmental destruction and desertification (UNEP 1984). As these concerns were augmented in the 1990s, with alarming reports of widespread soil nutrient depletion in sub-Saharan Africa (Pieri 1989; Stoorvogel and Smaling 1990; van der Pol 1992; Bationo *et al.* 1998; Lynam *et al.* 1998) and the equally alarming GLASOD world map of the status of human-induced soil degradation (Oldeman

[2] Soil degradation refers to the loss of productivity of the soil. See chapter 5 for a more extensive discussion.

[3] Land degradation refers to a decline in the resource potential of the land, whereby land refers to a terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system. This description is loosely based on UNEP (1997) and CCD (1997), but see chapter 5 for a more extensive discussion of the concept of land degradation.

et al. 1991),[4] the soil and water conservation engine picked up more and more steam. Soil and water conservation became a buzz-word and today the majority of rural development projects have a soil and water conservation component. However, notwithstanding a half century of interventions, the need for soil and water conservation is voiced only louder (e.g., Vlaar 1992; Kessler *et al.* 1995; Bationo *et al.* 1998). This suggests that despite the efforts, soil and water conservation until now has not been successful in mitigating the problem of land degradation. The question therefore arises whether there is something wrong with the doctor rather than the patient. Is the doctor prescribing ineffective medication in the form of soil and water conservation technologies, or worse, is the land degradation diagnosis incorrect?

Recent field and remote sensing studies (e.g., Fairhead and Leach 1996; Leach and Mearns 1996; Prince *et al.* 1998) suggest that the diagnosis of widespread land degradation in West Africa is questionable and others show that in some cases population growth may actually result in diminishing land degradation (Tiffen *et al.* 1994). At the same time there is a mounting body of evidence (e.g., Marchal 1979; Reij 1983; Marchal 1986; Shaxson *et al.* 1989; Hudson 1991; Reij 1991; IFAD 1992; Pretty 1995) that indicates that despite several shifts in research and technology transfer paradigms, soil and water conservation technologies have not been able to provide an effective cure for the perceived degradation problem. This raises questions about the effectiveness of the paradigms and the appropriateness of the technologies being extended in relation to the constraints that farmers face.

Burkina Faso, the focus of this study, is in many ways exemplary of this soil and water conservation crisis. On the one hand, Burkina Faso is claimed to be suffering from serious land degradation and desertification as a result of strong population growth coupled with inappropriate agricultural practices and an averse climate (see for example Vierich and Stoop 1990; Ramaswamy and Sanders 1992; PNGT 1993; Kessler *et al.* 1995; MEE 1996). In fact, it was one of the first West African countries to develop a national action plan (PNLCD 1985) to combat these problems. On the other hand, decades of soil and water conservation interventions made under different technology transfer paradigms have not led to widespread adoption of the proposed technologies (Reij 1983; Marchal 1986; Vlaar 1992).

In Burkina Faso, as elsewhere in Africa, interventions up until the 1970s were mainly based on what has been referred to as the paternalist or classic approach that either involved the local population through coercion or not at all (Biot *et al.* 1995). The GERES-VOLTA (Groupement Européen de Restauration des Sols en Haute-Volta) scheme, is a classic example of the failure of this approach (see for example Marchal 1979; Reij 1983; Roose and Piot 1984). Even before the three year project terminated in 1965, the fiasco was already beginning to emerge. Not only were the 35,000 km of ditches that had been constructed with heavy machinery not maintained by the local population (who had never been involved in the project), but the layout of the ditches completely ignored the existing

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[4] UN organizations had an important part in sounding the alarm. The study by Stoorvogel and Smaling (1990) was funded by the Food and Agriculture Organization of the United Nations (FAO), while the GLASOD (Global Assessment of Soil Degradation) project was funded by the United Nations Environment Programme (UNEP).

spatial organization of the land in terms of fields and footpaths. As farmers continued to cultivate their fields and use the old footpaths, breaches occurred and gullies formed. The anti-erosion network was soon run down resulting in more, rather than less, erosion (Marchal 1979).

Beginning in the late 1970s and early 1980s, the paternalist approach increasingly became the target of critique, not in the least from the emerging fields of Farming Systems Research (FSR), participatory research, indigenous knowledge studies, and political ecology. It was argued that there was a misdiagnosis of degradation issues, that there was a lack of fit between the proposed techniques and the local farming systems and livelihood strategies, a lack of participation by land-users in designing and implementing conservation technologies, as well as inadequacies of state bureaucracies charged with soil and water conservation strategies (Biot *et al.* 1995: 4). Farming Systems Research emphasized the importance of a multidisciplinary approach dealing with both technical as well as social aspects of a system, pointing to the complexity of smallholder farming systems (Chambers *et al.* 1989). Advocates of the participatory research school pointed out that much of the innovations offered by agricultural research so far were ill adapted to the resource-poor farmers that made up most of the Third World. It was stressed that the farmers' own capacity for innovation should be tapped for finding new ways to set priorities and develop and test technologies (Chambers *et al.* 1989). Indigenous knowledge studies (e.g., Brokensha *et al.* 1980; Richards 1985; Reij 1991; Reij *et al.* 1996; Prain *et al.* 1999) emphasized that land-users often have extensive knowledge of the local environment and through experimentation and adaptation have developed appropriate local soil and water conservation practices. Political ecology (Blaikie 1985; Blaikie and Brookfield 1987) instead drew attention to the difficulties involved in measuring land degradation and showed the necessity to take broader political and economic forces into consideration when looking at reasons for the use or non-use of specific technologies. From the 1980s onward these new ideas were increasingly brought into practice in, what is sometimes referred to as a populist approach (Biot *et al.* 1995): smaller scale initiatives, bottom-up participation of the local population, simple technologies and a concentration on so-called indigenous techniques.

As this new approach continues to be incorporated into mainstream development thinking, doubts have also arisen. Stories of successful interventions are few and the site-specificity of this kind of participatory approach limits the reach of interventions, leading to concern whether they can help attain the kind of radical land use changes that are said to be necessary (Vlaar 1992; Biot *et al.* 1995; Kessler *et al.* 1995). Projects alone are not able to treat more than a few hundred hectares per year, leading to estimations of a century or more to cover the whole cultivated area in a particular region at the present pace (Marchal 1986: 176; Kessler *et al.* 1995: 76). These and other criticisms have led in the 1990s, to what Biot *et al.* (1995) see as a neo-liberal counter-revolution, which instead emphasizes the role of institutions, political and economic incentives and the inter-relation between poverty, population growth, and land degradation. Advocates of this approach believe strongly in the availability of technological solutions and see a key role for land tenure reforms and economic policies in getting these technologies adopted by land users (Biot *et al.* 1995). While this new approach has been influenced by the populist approach in, for example, maintaining the emphasis on participation of local populations, it also has some elements of the classic approach in terms of the strong technology focus and the taking for granted of land degradation (Biot *et al.* 1995).

While open to critique, the populist and neo-liberal approaches have made a major contribution in that they have drawn attention to the complexity of the soil and water conservation issue. It is now well understood by both policy makers and development practitioners that more is required than the application of a top-down technological solution. The local population needs to be sensitized to the problem of land degradation, and, what is more, involved in the solution. Technologies need to be affordable and culturally acceptable. Existing land use rights need to be honored. Local power structures need to be acknowledged. Environmental conditions need to be taken into account. Macro-economic policies need to be evaluated. In other words, soil and water conservation is not only a technical issue, but just as much an economic, a social, and an environmental one.

Traditionally, research has had a techno-economic approach. It concentrated on scientifically developed conservation measures and the main interest was in valuing their ability to conserve soil and water and to contribute to higher productivity and income (Mazzucato and Niemeijer 2000). Research concerned itself with "the causes of adoption or non-adoption of technologies, which outside agencies have judged to provide technical solutions to the problem of degradation" (Biot *et al.* 1995: 22). Studies in fields such as political ecology, farming systems research and indigenous knowledge have helped to refocus soil and water conservation research. Increasingly the traditional question "why do farmers not adopt a recommended technology", is reformulated in terms of "why do they do what they do?"

Both the populist and neo-liberal approaches have thus made major contributions to the understanding of soil and water conservation in the African context and in reformulating research priorities. Neither approach has, however, been able to fully shed the legacy of the past. Several recent studies (e.g., Blaikie and Brookfield 1987; Scoones and Toulmin 1998; Scoones and Toulmin 1999) have pointed out that the concept of land degradation is problematic and poses serious measurement problems, yet most studies are still limited in the sense that land degradation tends not to be critically questioned (Biot *et al.* 1995). A further problem is that, while local technologies are now also considered, there continues to be a strong focus on technologies with insufficient attention to the role of the wider farming and livelihood systems in conserving the soil.

This study picks up here. To open new perspectives, a reconceptualization of both the problem (land degradation) and the solution (soil and water conservation interventions) is required. In other words, the trodden paths of soil and water conservation research need to be abandoned in favor of an approach that does not predefine the variables to investigate, based only on what have come to be the elements that a soil and water conservation study typically looks at.

In the first part of the book approach, analytical framework, and methods are discussed. Chapter 1 presents the approach used in this study: how theory is used, the research strategy and design, and some of the implications of having such an approach. Chapter 2 presents the analytical framework that developed out of this study and serves as a guide to the information and analysis presented in the second part of the book. The first part of the book ends with chapter 3 that discusses the research methods that were used to put approach and theory into practice.

The second part of the book analyses the different aspects of soil and water conservation in eastern Burkina Faso. As the recent World Bank discussion paper "Rethinking research on land degradation in developing countries" (Biot *et al.* 1995) points out, there is a clear need for such case studies because they allow a contextualization in space and time of the land degradation – soil and water conservation nexus. Considerable attention is given to the historical dimension, because such a diachronic approach is better suited to understanding how farmers re-adapt their practices to changing circumstances, such as colonial rule, the diminishing rainfall levels of recent decades and an increased market integration. Chapter 4 presents the research area and villages, and discusses at length the changes that occurred over the twentieth century and how these have affected agriculture.

Soil and water conservation interventions are first and foremost a response to the perceived land degradation problem. Chapter 5 critically examines the evidence for land degradation at the national, regional, and village level and points to the need to gain a better understanding of how farmers go about conserving soil and water.

The chapters that follow address the challenge set forth in chapter 5 by looking at soil and water conservation from multiple perspectives. Agricultural decisions emerge from a complex set of conditions in which knowledge, perception, absence of choice, bargaining, confrontations, and complementarities between various individuals all play a role (Biot *et al.* 1995). Chapter 6 focuses on technical aspects of the issue from a farmers' knowledge perspective. However, it is not limited to a description of local soil and water conservation practices, as is now commonly done in indigenous knowledge studies (e.g., Reij 1991; Reij *et al.* 1996), but tries to explore the relationship between farmers' theories of soil formation and degradation processes and their use of soil and water conservation technologies.

Because, as has been argued, soil and water conservation is not just a technical issue, chapter 7 explores how the changes the research area has undergone in the course of the twentieth century have affected the economic principles on which agricultural decisions are based. No a priori assumptions are made as to the type of economy, traditional or market, that guides allocative decisions. Instead, the chapter explores the social institutions guiding local economic reasoning.

The analysis of chapter 7 indicates that social networks are an important institution guiding economic decisions. Chapter 8 investigates how social networks, and their change over time, affect the way land is cultivated. In doing so, chapter 8 explores to what degree institutions such as social networks contribute to environmental sustainability in the form of invisible, and therefore often ignored, aspects of soil and water conservation.

Part 2 ends with chapter 9 that draws together the different pieces of the puzzle presented in the earlier chapters. It combines the evidence related to land degradation presented in chapter 5 with the analyses of local history, local knowledge and conservation technologies, local economic reasoning, and the role of social institutions, of the other chapters in part 2, to determine whether and how the livelihood system has been able to cope with social and environmental change, including a rapidly growing population.

The final analysis, presented in the conclusion, pulls together the analytical framework in part 1 and the evidence presented by the case studies in part 2. It argues that a re-evaluation of the evidence for land degradation together with a detailed analysis of local soil and water conservation practices and the evolution of local institutions not only points at problems with the current diagnosis and medication. It can actually help us to understand the ways in which, and the conditions under which, local farmers are able to develop their agricultural practices in a sustainable way. Rethinking soil and water conservation also sheds light on the repeated failure of soil and water conservation interventions to-date and offers some important implications for the ways to study African agricultural systems.

To be able to deal with the aforementioned complexity of the subject matter without loosing track of the argument, each chapter starts with a brief introduction that places the chapter in the context of the organization of the book as a whole. Furthermore, while chapter 2 presents the analytical framework developed in this study, chapters 5 through 8, each discuss a relevant theoretical issue in more detail.

Part I Approach to Theory and Methods

1. An open approach to soil and water conservation

> Science is, after all, nothing but a continuing effort to find the right questions, followed by the search for answers. And the question is often more important that the answer. (Morgenstern 1950: 29)

The introduction set forth the challenge to understand the use of soil and water conservation technologies by questioning what are the relevant aspects to be investigated. This requires deviating from the path usually trodden by studies that use a techno-economic approach. These latter studies measure and analyze pre-defined variables. Consequently, the approach guiding this study needed to be open enough to allow the exploration of the different aspects of soil and water conservation that constitute the complexity of the topic alluded to in the introduction.

This required us to deviate from the original proposal for this study, which was entitled "A systems approach for the quantitative analysis of traditional soil and water conservation techniques in the African Sahel". The emphasis of the proposal on a systems approach was useful in highlighting that more needed to be looked at than only the physical structures or objects that are part of soil and water conservation technologies. However, the perspective taken by the proposal placed a strong emphasis on a quantitative approach within a positivistic research paradigm. As such, it did not differ substantially from the techno-economic approach mentioned earlier, except that the focus was on the technologies that farmers use and not the scientifically developed technologies traditionally focused upon in soil and water conservation studies. In other words, it was necessary to break from the original proposal and develop a more open approach that will be presented in this chapter.

This approach has implications for the analytical framework (chapter 2) and choice of research methods (chapter 3). Furthermore, the approach has determined how soil and water conservation has been looked at in this study, as well as which aspects have been focused upon, and as such, is at the basis of the information presented in part 2 of the book.

Below, the approach is discussed by highlighting the main research questions in section 1.1, followed by a discussion of how theory is used in this study in section 1.2. Research strategy and design are discussed in section 1.3, while the two subsequent sections deal with the attitudes that an open approach requires of researchers. Concerning the latter point, it will be argued in section 1.4 that to fully exploit the unique opportunity of having two researchers from different disciplines required us to find ways of working together that go beyond simple multidisciplinarity. Section 1.5 deals with attitudes required in working with villagers in order to achieve a truly open approach that is not hampered by miscommunication and false expectations.

1.1 The research questions

Three fundamental questions underlie this study:

1. What evidence is there of land degradation in the study region?
2. How do people go about conserving soil and water?
3. Why do people go about conserving soil and water in the way that they do?

The first question, addressed in chapter 5, stems from the recent controversy between theories which forecast widespread and irreversible land degradation in light of Africa's rapidly increasing population, and theories which instead argue that communities adapt to changing circumstances and thereby find ways to conserve natural resources despite or even due to increasing populations. This debate is discussed extensively in chapter 2, which presents the analytical framework developed in this study. In order to anticipate questions related to the representativeness of results found in the study area chapter 5 addresses the matter of land degradation not only for the research area, but also at the national level.

The second and third questions can only be answered by looking at the agricultural system in its complexity. Chapters 4, 6, 7, and 8 all look at different aspects that revealed to be relevant in the course of the study. Thus attention is given to historical changes in the social context that affect how agriculture is conducted (chapter 4), the technologies and skills that farmers apply to their fields (chapter 6), the considerations that lie behind farmers' livelihood decisions (chapter 7), and how farmers organize themselves around the land in order to be able to practice agriculture in the way that they do (chapter 8). Chapter 9 then integrates these different pieces of the puzzle to see how they can explain the picture that emerged from the first question, concerning the evidence of land degradation.

Together these three questions form the basis of the present study. The condition of the land cannot be understood without studying how people use the land and the reasoning that guides their decisions about land use. It is only by addressing these questions that insights are gained into the current debates as to whether a system maintains environmental sustainability in light of a growing population. How we went about addressing these questions from a theoretical point of view, as well as in terms of research strategy and methods, is the topic of the subsequent sections as well as the next two chapters.

1.2 Grounding our approach

Having an open approach did not mean that we operated in a theoretical vacuum. Rather, the approach is grounded along the lines of grounded theory methodology as developed by Glaser and Strauss (1967). The grounded theory methodology has as its basic premise that theory should emerge from what is being observed.[5] It was developed in reaction to the standard research procedure of testing hypotheses derived from the work of a few theorists. The method entails collecting information and constantly comparing it with previous information. Through this process categories of the information are formed. The comparison continues until the theoretical properties of the categories are generated. At the same time, categorizing reveals which additional data are required to further develop the categories. In so doing a grounded theory is formulated. But the grounded theory methodology is not just a one-way process going from data collection to theory, but also, as Locke (1996) points out, the materializing theory plays an important role in guiding ongoing data collection. For these reasons fieldwork for this study was expressly organized in various stays, rather than one long stay, so as to combine periods of field research with periods of analysis and theory formation.

Subsequent to their 1967 publication, Glaser and Strauss have departed from each other on specific aspects of this methodology, creating two schools among the advocates of grounded theory. We will discuss two important differences that have affected our approach. The first difference relates to the use of theories. While the Glaserian school prefers that the researcher bring no a priori knowledge into the research project, the Straussian school allows for the potential use of existing theory, non-academic publications, and personal and professional experiences to inform the collection and analysis of data (Locke 1996).

Following the Straussian approach, we selected research villages with characteristics that theory suggests influence soil and water conservation activities. For example, differences in population pressure between the two villages were expressly sought, given that theories consider population growth either as a cause or a remedy to land degradation (chapter 2). At the same time, though, we did not pre-define variables or aspects of soil and water conservation that we wanted to study so as to allow the relevant aspects to emerge from the fieldwork. This meant starting with a broad focus. We asked people about their lives and history and focussed on making a village picture book (see section 1.5). In fact, the first fieldwork period of five months we never even mentioned the words soil and water conservation.

A second difference between the two schools relates to the role of objectivity in research. Grounded theory rejects determinism; individuals are seen as actors responding to local conditions and to the consequences of their actions (Corbin and Strauss 1990). Although this principle is at the basis of both schools, the Glaserian school remains close to the classic grounded theory approach with a post-positivist or critical realist paradigm. In this paradigm "different natural and social realities exist, but ... both forms of reality are probabilistically apprehensible, albeit imperfectly" (Corbin and Strauss 1990: 385). Objectivity is seen as an epistemological ideal; prediction and control remain theoretical aims. The Straussian school, instead has shifted towards a constructivist or relativist paradigm. In this paradigm, multiple, socially constructed realities exist but they are not governed by any natural laws (Guba and Lincoln 1989). Consequently, methods that try to verify or falsify are in antithesis to constructivist methodology.

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[5] This section is partly based on the description of the grounded theory approach in Stein (1999).

Being influenced by the Straussian constructivist paradigm, we recognize the existence of multiple realities defined by different perceptions about issues, objects or relationships. In our view emphasis must be given to understanding the different perspectives around a problem or issue if the complexities of the problem are to be understood. Thus the strongly positivistic nature of the original research proposal in which the emphasis lay in measuring an objective reality, changed to a more constructivist approach in which importance is given to understanding different perspectives about the use of soil and water conservation technologies.

The constructivist paradigm explains our taking seriously both the theories developed by positivist scientific analyses about land degradation (chapter 5), as well as knowledge held by farmers based on their daily experiences with the social and natural environments in which they live (chapters 6, 7, and 8). Chapter 5 looks at theories of land degradation within their own positivist paradigm, that is, the claim of land degradation is questioned based on the same data and methods on which the claim is based. However, this is done, not as the ultimate proof of the existence or non-existence of land degradation, but as one of the methods to gain insight into what is happening to the land and to help provide an argument for the need to go deeper with other analyses to understand the complex processes behind environmental changes. Furthermore, the remainder of the chapters do not take the positivistic techno-economic approach that assumes one reality: that of scientific technologies and capitalistic economic systems. Rather, soil and water conservation is studied by giving primacy to local technologies and institutions, allowing for the possibility of more than one dominant or correct system. Chapter 6 approaches the study of soil and water conservation technologies through an understanding of farmers' knowledge about their soils, theories of soil processes and their methods to restore nutrients to the soil. Similarly, chapter 7 analyzes some characteristics of the economy by focussing on locally relevant economic concepts while chapter 8 uses these concepts to make sense of agricultural decisions that farmers make.

1.3 Research strategy and design

The case study is the principle research strategy of this study while a diversity of methods have been used either within or in conjunction with this research strategy. As part of the case study strategy we opted for a research design with two villages[6] in eastern Burkina Faso as case studies, in which 35 individuals were selected as embedded case studies. The different chapters of this book use the information from the case studies to differing degrees depending on the research question they address (section 1.1).

The difference in research questions addressed in the chapters explains their different use of case study data. Chapters 4, 6, 7, and 8 that address the question of how people go about conserving soil and water, make the most intensive use of case study data as case studies are the most appropriate research strategy for addressing questions aiming at explanations of "how" and "why" (Yin 1994). Chapter 4 also provides some additional

[6] Originally more villages had been chosen for the study but the number was later reduced to two. See chapter 3 for the reasons why and for criteria for village selection.

information about the region using a historical research strategy based on archival documents. Chapter 5 instead, which addresses the question whether there is land degradation in the study area, uses a research strategy based on the analysis of secondary data to study trends at the national and regional level in conjunction with information from the case study villages, such as soil samples.

Despite the fact that both chapters 4 and 5 also make use of other research strategies, the case study remains the prevalent way in which information has been collected, analyzed, and presented in this study. The appropriateness of the case study strategy for this study is argued below.

A case study research strategy involves a smaller number of cases than, for instance, a survey research strategy. This allows a researcher to delve deeper into questions relating to interpersonal relationships, attitudes, and reasons for behavior (Casley and Lury 1982) than when he or she has to cover a large sample. When the case studies are individuals, the limited number of cases further helps foster a relationship of trust with those individuals. This relationship between the researcher and the "researched" is what allows insights into certain types of sensitive information, as was the case in this study for certain types of gift giving and livestock possessions.

The case study strategy also allows the use of a wide variety of research methods, which is particularly important for this study given its interdisciplinary nature (section 1.4). Case study research is most closely associated with anthropological work and is often confused with ethnographic methods which focus on the use of close-up, detailed observation (Yin 1994). This is why case study research commonly conjures up images of qualitative research methods. However the case study research strategy can include highly quantitative research methods such as surveys (Yin 1994). In fact, various quantitative methods were used within in this study ranging from budget diaries to labor allocation studies and from yield measurements to soil sampling of people's fields. Furthermore, because all information, both quantitative and qualitative, is collected for the case study unit, the case study forms the integral link between different kinds of data. For example, we were able to link aspects such as life cycle stages with field management techniques with soil fertility levels through the case study individuals. As Reenberg (1997: 2) argues, case studies are fundamental in transcending "the division of natural and social science methodologies."

However, the nature of quantitative data collected within case studies is different from that of techniques using larger samples. Within a case study strategy much more accurate and skillful observations and measurements can be made than could be expected from enumerators working with large samples. At the same time though, given the limited number of cases, the data does not lend itself to standard statistical analyses. This is not to say that statistical analyses are not possible but it does mean that creative solutions need to be found for conducting analyses such as in the example given in section 1.4, on measuring the spatial variability of organic matter of the topsoil. In fact, generalizations from case studies are not the same that can be made from a survey research strategy. The first aims at analytical generalizations, that is generalizations which raise the findings for the case study research to the level of the theories guiding the phenomenon being studied (Yin 1994). The second, instead aims at statistical generalizations in which inferences are made about a population from empirical data collected about a sample.

The fact that the case study strategy allows in-depth analysis and a mixture of research methods, makes it a powerful tool for exploring new concepts other than those stipulated by theory. An example is the consideration of wealth. It is customary in economic analyses to consider wealth of households or individuals according to their income, or more often in African countries, according to possessions such as corrugated iron roofs, motorbikes, bicycles, livestock and the like. Using these criteria, the household to which two of our case study individuals belong would be considered as being quite poor whereas locally the household was considered to be well-off. It was only through in-depth, case study work that we discovered that such a poor-looking household was actually well-off and why this was so.

Triangulation of data sources is a central aspect of the case study research strategy because it gives accuracy and credibility to the conclusions that can be drawn from a case study (Yin 1994). Patton (1987) identifies four different types of triangulation, here we will talk about data and methods triangulation. Such triangulation entails obtaining information from multiple methods or data sources aiming at corroborating the same fact or phenomenon. Triangulation was particularly useful for this study in bringing out different perspectives around an issue, as well as for studying local concepts. For example, in this study we conducted an analysis of national level statistics, a land use study in which aerial photographs were analyzed, and interviews with farmers about their perceptions of trends affecting soil quality to get at the different perspectives around land degradation.

Also understanding local concepts requires obtaining information from different sources. This is because concepts of, for example, what wealth is, or what constitutes a good soil, or what is a good cultivation strategy, that affect decisions people make, relate not only to what people verbally know but also to their tacit or practical knowledge. This implies that to get at a concept one needs to observe, measure and interview. Practical knowledge is what people do without being able to give a reason for why they do it. It can be culturally created and enables people to deal with standard and recurring situations (Mosse 1994). Bloch (1991), in reviewing psychological studies, notes that certain complex tasks even require that knowledge be non-linguistic. The quantity of information and the speed with which it is to be processed requires that it be stored in instantly recognizable and usable "chunks", rather than in language-like sentence strings. A second factor that makes local concepts a difficult topic is that, even when knowledge is verbalizable, it is not homogeneous. For example, men may have different knowledge from women, agriculturists different from pastoralists, and a "good" farmer different from a "bad" farmer. This means that getting at local concepts is a complex process of applying different methods as well as using different sources of data.

The case study research strategy is also helpful in explaining subtle yet important differences between cases. These differences can easily be diminished when working with aggregative methods in which minor but important differences can get averaged out or, if they are highlighted through outliers, may be difficult to explain based on a survey. These differences are all the more important in variable environments where slight variations in rainfall or a family's labor availability can be the difference between harvesting enough food for one's family and not having enough to eat. The case study research strategy is appropriate for understanding these differences because it allows a focus on the circumstances leading to individual actions.

Finally, a last word is in order to explain how we reconcile the apparently contradictory approaches of a case study research strategy and grounded theory. The case study relies on theory in order to determine whether the case study strategy is the most appropriate research strategy, to select case study units, and to determine criteria for interpreting the findings (Yin 1994). Grounded theory instead deliberately avoids specifying theoretical propositions at the beginning of a study and aims at developing a theory out of the data collection process (Yin 1994). As we explained in section 1.2, our approach to grounded theory is similar to that of the Straussian school in which existing theories are allowed to inform the data collection process. For example, the selection of research villages was not made in a theoretical vacuum. Debates around the land – population nexus were behind the reasoning for choosing one village in a more populated part of the region and one in a less populated part of the region (chapter 3). The choice of research questions stemmed from the apparent gap in understanding of the dynamics behind the way in which farmers conserve soil and water. We did not use theory to a priori limit the choice of variables or aspects that needed to be looked at. That is, we did not go to the field with the idea that we needed to measure the length of stone bunds or sedimentation rates or agricultural prices, without first finding out which were the locally relevant aspects. Finally, the emphasis laid by the grounded theory approach on the development of a theory based on data collection lends itself well to the case study strategy in which generalizations from case studies (thus data collection) can only be made at the theoretical level (thus theory formation).

1.4 Interdisciplinarity and integrating disciplines

Any intensive research endeavor is a learning process. One of the most important lessons of this study was learning to work in an interdisciplinary fashion. There are various aspects to interdisciplinarity, the most evident of which is going beyond one's own disciplinary boundaries. Our approach of studying soil and water conservation from different perspectives meant allowing the subject-matter to determine what needs to be studied rather than a researcher's own discipline. We were advantaged by the setup of our research: two researchers from differing disciplinary backgrounds (development economics and environmental geography), both working on the same research question. But even having two areas of expertise did not prevent us from having to step beyond the "safety" of our disciplinary backgrounds. For example, as the importance came to the fore of local institutions and histories for understanding how soil and water conservation technologies are used and change over time, we found ourselves needing to draw from the respective disciplines: anthropology and history. Furthermore, in order to understand certain dynamics at the field and plot levels we needed to take certain agronomic measurements.

But going beyond disciplinary boundaries is only part of the difficulty. A more challenging difficulty lies in trying to integrate the perspectives generated by different disciplines in order not to end up with parallel stories and nothing to link them to each other. This has important methodological consequences. In the present study a sampling design was chosen in such a way as to permit linking production data with field management styles with social histories. Physical units (fields, plots, sampled areas for crop cuttings) were selected to coincide with the social units, that is individuals, in order to be able to link human and physical factors. However, this meant working at times with a sampling design that is not the one used in standard statistical analyses and required the development of alternative methods for statistical analysis. For example, to determine the spatial variability of organic matter content of the topsoil on fields, a random or grid sampling would be most appropriate to get a good distribution of samples over all distance classes. In our setup, however, we were limited to measuring the organic matter content of the topsoil on the fields and plots of case study individuals. This does not lead to an ideal distribution of the samples over all distance classes and may also lead to certain biases because the fields of case study individuals are not necessarily representative of the pool of all fields. In other words, the consequence of our approach is that the analyses of the physical measurements are a little less powerful than would have been the case if an ideal sampling setup could have been used for those measurements. However, being able to link aspects such as the management decisions of an individual to the soil fertility status of a plot gave us insights to certain dynamics that a dissociated sampling structure would not have revealed.

But most difficult of all in working in an interdisciplinary team is letting go of one's sense of self. Interdisciplinarity needs to begin with a common problem or question to investigate. At this point it is very tempting to divide one's work amongst the researchers because in this way each researcher has claim over a certain portion of the data or information. This division of labor is stimulated by the reward and incentive structure within academia that values the individual researcher most highly (doctorates are conferred individually, single authorship of journal articles is valued higher than co-authorship, the importance of being first author, etc.). It is also a safety mechanism in case of "divorce" between the researchers in which each researcher is ensured that a part of the research is considered as hers or his.

However, such a division of labor, while being perceived as a safety measure, can actually easily become the source of danger. When boundaries are clearly defined between researchers, and if the research problem is to be approached in an integral way as is aimed at through an interdisciplinary approach, then it becomes almost impossible not to transgress the boundaries, causing contention. If researchers instead are successful at not transgressing the boundaries, then they are more likely to have conducted two parallel studies about the same topic, which is characteristic of multidisciplinary studies, in which fundamental links may be missing.

Interdisciplinarity requires thinking and working according to the problem rather than in terms of a rigid division of labor between the researchers. In this study, both researchers were integrally involved especially in the design stage of all the methods employed and to varying degrees in collecting the data/information and analyzing it. In this way, the difference in disciplinary perspectives became a way to enrich the data that was collected rather than a bone of contention. For example, questionnaires were designed by both researchers together, so that a topic could be treated in an integrated fashion by including questions coming from different angles. Another example was the questioning about soil fertility management by one researcher at the same time and place as the soil sampling was carried out by the other researcher. Conducting these activities *at the same time and place* allowed both researchers to enrich their questions and observations from one activity with aspects that came up by virtue of the fact that another activity was conducted concomitantly. In general, this form of collaboration resulted in the researchers developing a common understanding of the problem rather than stick to pre-defined disciplinary perspectives.

We of course made use of our disciplinary expertise so that the researcher with knowledge about development economics was more involved with the collection of budgetary and market information and the researcher with knowledge in environmental geography was more involved with the collection of soil and yield measurements. However, not having divisions to demarcate which data is whose, gives a lot of freedom to divide the research tasks also according to the situation. For example, sometimes it was necessary to conduct activities with men and women separately. Given the sensitivity of some topics, these activities were divided amongst the two researchers according to gender rather than topic. Finally, being intensely involved in all aspects of the research meant that each researcher was sensitized to the different angles of the research problem and was thus able to take advantage of being at the right place at the right time by picking up on important statements made in casual conversation or noticing certain chance happenings, irrespective of the topic.

Daily discussions between the researchers during the fieldwork stage of the research were also fundamental. Findings were compared and contrasted, further directions to pursue were discussed, as well as frustrations were vented. These exchanges are not to be undervalued in allowing for the close collaboration necessary for interdisciplinarity.

Another difficult aspect to working in an interdisciplinary fashion relates to practical difficulties of collaborating closely: work schedules of the researchers need to be coordinated. Additionally, the integrated nature of interdisciplinary work makes a co-authored product the most logical research output. This means however, accepting that things may not be written or explained as would a single researcher. But the fact that an interdisciplinary approach creates an integral understanding of a research problem in which crucial linkages are drawn between different aspects of the problem makes us conclude, after having conducted this exercise, that the advantages make the effort worthwhile.

1.5 Working with villagers

A relationship of confidence between the researcher and the "researched" is a prime ingredient to any study for obtaining reliable information and gaining certain insights. However, such a relationship was even more fundamental for this study for two reasons. Firstly, the approach chosen based on understanding local concepts or categories and using these to guide our inquiry, required villagers to be willing to talk about sensitive topics with researchers and that researchers could observe certain activities. Secondly, a development discourse envelops the topic of soil and water conservation making it difficult to obtain reliable information. This second point is less evident and is discussed below.

Soil and water conservation is a topic intertwined within a development discourse to which farmers are exceptionally attuned. Virtually all development projects in the research area have a soil and water conservation component to them (Gaanderse 1998). This reflects a wider development trend encompassing most of the Sahelian and Sudano-Sahelian zones of Africa, encouraged, amongst others, by international donors. A consequence of the widespread soil and water conservation efforts is that farmers are well attuned to the discourse (Mazzucato and Niemeijer 1996b). As the answers received during a rapid appraisal survey show (chapter 3), farmers know which technologies are encouraged by development projects such as stone bunds, and when asked, cite these as some of the primary solutions to all their evils. However, the lack of adoption of these technologies places some skepticism on the part of the perceptive listener as to why, despite the attested popularity, these technologies are not being used.

Farmers may partake in the discourse partially to please outsiders in expectation of something that the outsiders will bring them, and partially as a way to protect themselves against any potentially harmful intervention through seeming to be collaborative and then engaging in foot dragging, absenteeism, etc. (Scott 1985). This behavior reflects villagers' previous experiences with outsiders. To avoid the discourse entails making a break with these images of outsiders that villagers have by building and maintaining a relationship of confidence with them. Some researchers, in particular anthropologists, build relationships of confidence with informants by living in a village for years at a time. However, having structured our fieldwork according to the iterative visits principle described in section 1.2, we had to develop innovative ways for building such a relationship in the absence of year-long stays. We spent most of the initial fieldwork period establishing relationships of confidence and many activities during the course of the research in maintaining these relationships.

During the first months of fieldwork we focussed on the use of participatory research techniques which were geared not only at gaining general knowledge about the research villages, but especially in creating a rapport of trust with the villagers. For this purpose we developed a participatory tool called the village picture book (Mazzucato and Niemeijer 1996c). We asked two women and two men who were selected by the village chief, to make photographs of the village depicting the village history, their livelihoods, and their day-to-day activities. The project to make a village picture book was an original way to begin working with the villagers that broke from their previous experiences with outsiders. Villagers were genuinely interested in creating such a book "to show to their children and their children's children". It became a joint project that allowed us to learn some general aspects about our research villages, but most importantly, it produced an initial platform for communication (Röling 1994) which broke down the unidirectional researcher-respondent relationship that is typical of most research projects.

The picture book was then used all along the course of the fieldwork as a place to show the research outputs. For example, we took photos of the genealogies made together with certain families, or of village maps made with villagers, and of visual representations of data collected by farmers for this study and put these all in the picture book held by the village chief. The "publicness" of these results made our research activities less suspicious. Similar picture books were also made with Dutch farmers to show the villagers how Dutch farmers live. This was done to encourage the two-way communication that is part of a relationship of confidence. The method and its utility for our research is described in detail in Mazzucato and Niemeijer (1996b, 1996c).

Fundamental was also the way we introduced ourselves to the villages. From the start we made it clear that we were not part of a development project and were in no position to supply the village with equipment or other forms of material aid. Instead, we explained that our objective was to learn about the way of life of the villagers, their history, and the way they provided for their livelihood.[7] In turn, we would be open for any questions regarding the way of life of people in our own country and on several occasions we brought to the villages some seeds or fruits to try and taste, and once staged an open air video session with videos about Dutch livestock and arable farmers. We further pointed out that for any kind of development to be effective it is important to understand the way people live. What we would write about the knowledge that we gained from them might therefore someday be beneficial to farmers in the region in general. Notwithstanding this introduction, during the initial stages of the research, villagers expected that someday a water pump or school would be financed by us. But, in the course of time, as a relationship of mutual confidence became more established, the people we worked with most closely began to believe this unlikely story of a project that only asked questions and did not supply any material goods. Stating the objectives of our project clearly right from the start helped to gain confidence of the villagers and made it possible on later occasions, when some of the ice had been broken, for them to discuss with us their concerns or worries related to our presence (such as whether we were going to take away their land).

Another important decision that has influenced our relations with the villagers was that we decided not to remunerate informants for information. Whether to remunerate is often an important consideration in anthropological studies (Bernard 1994). We felt that remunerating informants in an outwardly egalitarian society such as that of the Gourmantché might lead to contention between informants and other villagers, which would reflect negatively on us and our work. In addition, it seemed to us that information supplied by individuals who had a genuine interest in cooperating with us would be more useful than information supplied in exchange for payment. This does not mean that we did not show our appreciation. Rather, it meant that we used other, culturally more appropriate ways to establish relations with informants. To some degree we exchanged gifts, offering for instance kola nuts to the village chief, or bringing salt to compounds in which we lodged, while receiving, for instance, chickens or eggs from villagers. More importantly, as is customary among villagers themselves, we gave small amounts of money at the occasions of baptisms and funerals, and, for instance, offered soap in case of births. We also occasionally brought people pictures that we had made of them during fieldwork. By limiting the amount of gifts we offered, we have probably been able to avoid contention, but also still feel very much indebted to, especially, the case study individuals who shared so much of their time and knowledge with us.

[7] One of the reasons we put it this broadly was to avoid the earlier mentioned development discourse surrounding soil and water conservation. Had we said that we wanted to study their soil and water conservation practices, we would have received the standard answers of the development discourse.

Aside from the village picture book and the exchange of gifts there were other ways in which we fostered a relationship of mutual confidence with villagers. We participated in funerals of important elderly persons, organized a work party (a local practice when in need of additional labor) to dig pits for soil profile descriptions, rather than pay people in cash for their help, and kept villagers updated on the status of our research through the village picture book. At the end of the fieldwork, in order to produce something that, also for the villagers, could be considered a clear product from our three years of cooperation, we made an agricultural booklet in the local language. This booklet contains a compilation of quotations from farmers on various aspects of agriculture, collected during the course of the study. The booklet (Conbiani *et al.* 1998) was published jointly with a local, non-governmental organization, which uses the booklet as part of its literacy courses in the region, and is a source of pride for the villagers.

1.6 Conclusion

The open approach put forward in this chapter has major implications for the way theory, methods and findings have been integrated in this study.

In terms of theory it implies that, rather than starting out with a preconceived conceptual framework, we worked with a grounded theory methodology in which the principles that formed the object of the study emerged from the fieldwork. The analytical framework discussed in the next chapter should thus be considered a product of research, and not a starting point. Nevertheless, we have placed it at the beginning of the book because it presents our line of reasoning and is thus helpful in understanding the logic of the chapters in part 2.

In terms of research methods, the open approach of this study requires the use of a broad basket of tools to be able to deal with the multifaceted nature of the topic. This means that methods from various disciplines need to be used and that much time is asked of farmers. This has led to a larger than usual chapter on research methods (chapter 3), despite the fact that each of the methods is only briefly discussed.

In terms of findings, rather than discuss the results of each method sequentially, the results are presented where they fit best in the overall argument, transcending the disciplinary boundaries where necessary. The results are integrated throughout the chapters in part 2, often after triangulation with results from other methods. This has the drawback that it may not always be clear from what method a certain statement or figure is derived, but it has the major benefit of allowing us to present an integrated story in which linkages between different kinds of data are made.

Finally, the emphasis we placed on building and maintaining relationships of confidence meant that we invested heavily in them in terms of our research time. However, we were able to avoid tensions that can sometimes arise between researchers and villagers, and we have seen how these relationships have enhanced the quality of the information collected, as well as permitted certain insights that would have been difficult to obtain otherwise.

2. A framework for the study of soil and water conservation

> The research question of how decisions on land management are made in any case must be complex and will involve analysis at a variety of different levels and linking them with the social relations of those who make them. (Biot *et al.* 1995: 25)

Having seen in the introduction to this book that soil and water conservation is a complex issue in need of new ways of studying it, here we explain the framework developed for this study. We present this framework at the end of the process that created it and as such, it may appear more of a fixed product than it really was. In practice, the framework developed out of an iterative process in which fieldwork was interspersed with periods back at our university. In total we conducted six fieldwork periods spread over three years. This organization of fieldwork led to an iterative process in which preliminary results were analyzed, reflected upon, and compared with current theories influencing the study of soil and water conservation while we were at our university, and data collection tools were adapted, new concepts were investigated, and lines of questioning were readjusted each time we returned to the field. The framework here presented is thus the product and not the starting point of our research. It is nonetheless presented at the beginning of the book, because it shows our line of reasoning and as such serves as a guide to the reading of the book. We present the framework against the backdrop of theories that have been most influential in guiding the study of soil and water conservation and argue what aspects thereof we have used, modified, or rejected.

In the first section (2.1) of this chapter, we discuss one of the major *raisons d'être* for soil and water conservation technologies, that is land degradation. Soil and water conservation technologies are seen as an important solution to the land degradation problem. But what is land degradation? Is it happening? And how should it be conceptualized in a study about soil and water conservation? At the same time, soil and water conservation technologies are focussed upon as means through which to increase agricultural production in order to feed an ever increasing African population. In section 2.2, we look into the question, why should solutions to land degradation and stagnating production be focussed on technologies? And how should technologies be studied? Theories are discussed that provide the reasoning behind the role of technologies in averting land degradation and doomsday scenarios. In section 2.3, we discuss a third element that is commonly ignored in soil and water conservation studies, that is, social institutions.[8] How have social institutions and their change over time affected, and been affected by, conditions of agricultural production? Finally, section 2.4 links the developed framework with the chapters in part 2.

2.1 Land degradation

It was explained in the introduction that the resurgence of soil and water conservation as one of the most pressing development needs in Africa is fuelled by the belief that large parts of the continent are heading towards irreversible land degradation unless something is done to halt these trends (FAO 1983; IFPRI 1995; Pimentel *et al.* 1995). However, we will argue in this section that the discussions around land degradation have been largely influenced by ecological and social theories that are characterized by equilibrial and/or linear thinking. In our view, equilibrial and linear thinking do not do justice to the constantly changing context within which soil and water conservation is practiced.

Firstly, ecological theories have largely influenced the land degradation debates. Underlying these theories, through to the 1960s, is the assumption of a previously existing equilibrial state in which social and natural systems were in harmony with each other. According to these theories, land degradation processes result as a consequence of human action which, due to population pressure, disrupts the previously harmonious state. Key concepts in ecological science, such as gradual, linear change, homeostatic regulation of systems and stable equilibrium points or cycles were grounded in a notion of a "balance of nature". A review of these older theories by Leach *et al.* (1999) give the following examples of the reasoning used in these theories. Theories that explained the succession of types of vegetation were based on linear change and stable and natural climax. Thus environmental change is often measured against this theoretical natural state and restoration programs are set accordingly. Similarly, models of livestock population dynamics, which identify carrying capacities and the necessary biomass production needed to sustain such a system are based on linear growth patterns in stable environments. Ecosystem theory explains the flows of energy and matter within a natural system based on a homeostatic regulation mechanism characteristic of natural systems, which, if disturbed, will collapse leading to detrimental consequences.[9] Furthermore, conservation biology claimed a stable relationship between species diversity and area. Exclusionary policies regulating nature reserves and national parks are based on this type of analysis.

Secondly, land degradation debates have also been influenced by "crisis" theories about population growth. These theories stem from the end of the eighteenth century and beginning of the nineteenth century, in which Malthus (1803) argued that population, if left unchecked, grows more rapidly than food production. Ricardo (1817) added that land,

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[8] Although all institutions are social, we use the term "social institutions" in order to distinguish between the vernacular use of the term institution and how, instead, the term is used in this study. The term institution is used colloquially to refer to organizations such as the World Bank or a research institute, whereas the broader term used in this study includes not only organizations but also social norms, kin networks, customary law, rules and the like, which guide people's behavior within a society.

[9] For an example of how Sahelian grazing systems may collapse, see Rietkerk (1998), who discusses the application of catastrophy theory to the vegetation dynamics of the African Sahel.

being limited, would provide the prime impediment to agricultural growth. He distinguished between two types of agricultural growth. The first was the extensive margin, in which expansion onto new land would lead to diminishing returns to labor and capital because new land was presumed to be more distant or of poorer quality than land already under use. The second was the intensive margin, in which more intensive cultivation on existing land would take place through more land enhancing methods such as fertilization, weeding, draining, etc. However, this too would eventually lead to diminishing returns to labor and capital. Both types of agricultural expansion represent a linear progression towards a doomsday scenario in which insufficient growth in food production leads to large-scale deaths due to starvation.

An increasing number of studies (see for example Leach and Mearns 1996) are bringing into question the generalizability of degradation trends for the whole of Africa. Afikorah-Danquah (1997), Fairhead and Leach (1996, 1998), and Kepe (1997) document cases in South Africa, Guinea, and Ghana in which landscapes over the last century have gained in tree cover. Also during the course of this study various indications brought the generally believed land degradation trends for the study area into question. These studies, along with signs that we were observing during fieldwork, highlighted the need to re-examine the evidence on which stories of land degradation are based, as well as question the way in which land degradation is conceptualized (chapter 5).

Different disciplines such as cultural geography (Duncan and Ley 1993), social anthropology (Guyer 1996; Guyer and Richards 1996) and "new ecology" (Scoones 1999) have contributed towards a new conception of landscapes which challenges "old ecological" and Malthusian thinking. In their view, landscapes are seen as transforming, not just degrading, and emerging out of a dynamic interaction of social and ecological histories, not just the result of deterministic patterns of environmental change (Leach *et al.* 1999). Through this approach to landscapes, the focus is much more heavily laid than previously on spatial and temporal histories of ecological and social processes (see also Reenberg 1996). Ecology and culture are no longer deemed to have been in equilibrium, but rather seen as being in a constant and dynamic relationship, making their histories inseparable. We use this conception of landscapes because it allows us to understand the interaction between changing natural and social contexts, on the one hand, and conditions of agricultural production, including the use of soil and water conservation technologies, on the other. This allows us to approach the complexity behind soil and water conservation that was alluded to in the introduction to this book.

Another recent development is in the field of political ecology. The first studies founding this school of thought (Blaikie 1985; Blaikie and Brookfield 1987) appeared in the 1980s in reaction to the a-political nature of the debates around land degradation. These studies highlighted how broader political and economic forces are responsible for guiding debates around land degradation and in providing solutions to it in the form of soil and water conservation. They argue that claims about land degradation are based on very few sources, some of which contain dubious data (Blaikie 1989), but that these claims continue to be propagated for political and economic ends. The way things are presented as facts, and who decides that they are facts, greatly influence how the debate is shaped. Political ecology has been fundamental in placing the emphasis of research on land degradation on questions such as who are the actors involved, who is setting the agenda, and how are resources accessed? However, a weakness of political ecological studies is that they are often centered around issues rising from intensifying environmental problems (Bryant and Bailey 1997), but hardly ever explicitly tackle the difficult task of dealing with the data on which the stories about environmental problems are based. This stems from the fact that political ecology is largely dominated by a single discipline: human geographers, with some contributions from political economists and anthropologists, but with little involvement from the "hard" sciences. In this respect, the extension of political ecology, called political environmental geography (Dietz 1996, 1999), which mixes technical land-oriented analysis with political ecology, may offer some solutions.

The argument that land degradation depends on the perspective of the actors shaping the debates, is shared by various other disciplines. Recent studies in public policy argue that development narratives are created to suit political agendas (Roe 1991, 1995). A recent collection of studies (Leach and Mearns 1996) provides further evidence of this phenomenon. Also in the field of communication science, concepts such as "the soft side of land" (Röling 1997) are used to highlight the fact that environmental sustainability is the emergent property of negotiations between actors with different perspectives and goals. These developments emphasize that land degradation is a subjective matter, rather than an objective truth as it is usually presented.

The fact that land degradation is a value-laden term means that how it is perceived is influenced by culture and can change over time. An example of the role of cultural perceptions, is that what one land user may consider as beneficial to productivity another one may consider detrimental. Bassett and Zuéli (1996), for example, show that in northern Ivory Coast grasses are disappearing to the advantage of shrubs and trees. Cattle herders see this as a land degradation problem: their grazing land is disappearing. Farmers, on the other hand, perceive it as a change that enhances the quality of the land due to the resulting increase in organic matter production. Thus indicators of land degradation depend on one's preferences, which in turn are determined by such things as one's productivity objectives, mores and values.

An example of how the value assigned to types of land use, and therefore how land degradation is perceived, changes over time is how cultivated landscapes have been viewed in Western Europe. Whereas once in Western Europe, cutting down a forest or draining a swamp to allow settlement or farming was seen as a "good" action, showing the mastery of humans over nature,[10] now forests and swamps are being protected and certain agricultural lands are "turned back into nature".

In this study, we take the view that because land degradation has become so ingrained in the development discourse, there is a need to question the evidence on which the discourse is based (chapter 5). Through this questioning one can gain insights into environmental change and point to the need to go further in understanding the dynamics behind this change. Furthermore, there are methodological consequences if one is to take

[10] It is not a coincidence that some languages, such as Dutch and English, use the expression "to bring into culture" for the clearing of new land for crop cultivation. The word "culture" in these and other languages (e.g. French) has both the meaning of "civilization" and "arable farming".

the idea of discourse seriously. Farmers, being the recipients or partners of development projects, can eloquently elaborate on the discourse around land degradation and soil and water conservation technologies as a solution to it. We therefore had to spend much time and develop innovative tools (discussed in chapter 1 and in Mazzucato and Niemeijer 1996a, 1996b, 1996c) in order to get beyond the discourse with farmers. Also, recognizing the importance of perceptions, we paid attention to farmers' theories about soil formation and degradation processes (further discussed in section 2.2.2). In assessing the effects of farmers' land use patterns on the environment, we view landscapes as the dynamic arena in which interactions between changing natural and social environments take place. This means paying attention to historical processes and linking changes in the natural environment, farmers' practices, and their social institutions. We do this through the perspectives discussed below.

2.2 The role of technologies and technological change

Soil and water conservation technologies have always occupied a central role in solutions to land degradation problems. This started as early as the 1930s, when colonial governments became concerned with land degradation issues (Anderson 1984; Stocking 1985; Swift 1996). More recently, as rapidly growing populations in Africa have become a concern in the international arena, soil and water conservation technologies are seen as the means through which to obtain the necessary increase in agricultural production without degrading the land (introduction). Two popular theories have provided the reasoning and impetus behind the strong technology focus of agricultural development studies and interventions since the late 1960s: Esther Boserup's (1965) theory on the relationship between population growth and agricultural change and the theory of induced innovation introduced by Hayami and Ruttan (1985) in the early 1970s.

2.2.1 Population growth and induced innovation

Esther Boserup (1965) was one of the first development economists to theorize the relationship between population growth and agricultural change. In this theory, technologies play a central role in allowing food production to grow along with population. Hayami and Ruttan (1985) developed, in the early 1970s, an induced innovation model to agricultural development which theorizes how technological change occurs. Both of these theories are discussed below.

Boserup (1965) analyzes different trends of technological development of countries and continents over centuries and concludes that population growth provides the impetus for technological change. Boserup showed that the increased need for food and land scarcity caused by population growth was commonly countered by an intensified use of technologies in which more labor was used in conjunction with land improvement technologies. Land would be cultivated more intensively, more investments were made in permanent land improvement structures, as well as more careful husbandry was practiced. Thus more people provide both the stimulus as well as the means to new kinds of land management.

Boserup's (1965, 1981, 1987) line of argumentation is as follows. Population growth induces greater frequency of cropping to meet food needs. The maintenance of yields on land that is more frequently cultivated requires more labor inputs not only into farming but also into farm improvements such as soil conservation, irrigation, terracing, etc. With more frequent cropping and more labor investments, land tenure will shift from being tribal or feudal based to private property based. With higher population density, the per capita cost of communication infrastructure is reduced. This will lead to cheaper transport which in turn creates local specialization between towns, thus raising demand for food and increasing farm-gate prices. Farmers will earn higher incomes and they will be inclined to invest more labor and capital into farming. As population growth continues, more mechanical and chemical inputs are required. In this stage then, increased farm output depends increasingly on cash investments and market sales. Capital investments are both stimulated by, and necessitate access to, external markets.

Thus changes in technologies happen at certain "thresholds" when demands of a population reach a peak and force a change in agricultural techniques to improve per capita production. Elaborations of Boserup's thesis explain that increasing pressure on the agricultural system results in diminishing returns to factor inputs until a new threshold is reached (Robinson and Schutjer 1984; Kates *et al.* 1993). This results in a "stair-step" growth pattern in which each step is characterized by improvements in land productivity.

Recent studies (see for example Brouwers 1993; Tiffen *et al.* 1994; Adams and Mortimore 1997) arguing against the Malthusian doomsday land degradation scenarios in Africa, have renewed the interest in Boserup's theory, given its usefulness in explaining why more people do not necessarily lead to more degradation. These studies document historically how communities in Nigeria, Benin, and Kenya first had low population densities and farmers could easily practice extensive agriculture. As population densities increased, nutrients were taken out of the soil faster than they were replenished until degradation processes overwhelmed both ecological and social systems. This crisis point coupled with continuing population growth provided the impetus for institutions to change, which in turn changed the set of opportunities that farmers were faced with. This allowed farmers to amend their ways of cultivating and they adopted, adapted, and developed soil and water conserving technologies that reversed the degradation trend.

It is important to note, however, an aspect of Boserup's original work that is little acknowledged in the recent quest to explain non-degrading situations. She highlights that if rates of population growth are too high, the conditions stimulating technical change may not occur (Boserup 1965: 118). Furthermore, she argues that without knowledge of improved land husbandry methods, populations at high densities may be forced into using land degrading techniques (Boserup 1965: 41). Recent case studies which test Boserup's thesis, indeed, reveal a more nuanced picture. Hyden *et al.* (1993), after commissioning 10 case studies in five African countries, conclude that population growth does drive agricultural intensification, but whether this leads to increased well-being and environmentally sustainable practices is ambivalent. Lele and Stone (1989), after six African case studies, add that public policies are fundamental in shaping the effects that higher population densities will have on agricultural change. Without appropriate policies higher population will lead to degrading trends.

Hayami and Ruttan (1985) developed an induced innovation model of agricultural development with market mechanisms central to their argument, but based on similar reasoning as that of Boserup. The authors argue that a country is endowed with a certain quantity of production factors (inputs that go into the production process). As one of these factors becomes more scarce relative to the others, prices for the scarce factor will rise, creating incentives for innovations facilitating the substitution of more abundant factors for the scarce one. According to this reasoning, thus, if land becomes scarce due to rising populations, higher land prices will provide the incentive for innovations to occur that substitute or facilitate the substitution of land as an input to production. Such innovations could be a set of biological or chemical technologies such as increased maintenance of soil fertility by more labor intensive conservation systems, chemical fertilizers, husbandry practices, management systems, and inputs such as insecticides that facilitate the substitution of labor and/or industrial inputs for land.

These theories have been fundamental for pointing to the importance of technologies and technological change in allowing for production increases that will avert a Malthusian crisis scenario of insufficient production and land degradation. However, given the types of technologies and institutions emphasized in these theories (agricultural research and extension organizations and the technologies developed by them), these theories reinforced the dominant agricultural development paradigm of the twentieth century which seeks to replace indigenous agricultural systems with agricultural models proven outside of Africa (Richards 1985). Economic studies, showing high rates of return to research investments, emphasized the importance of scientifically developed technologies (Evenson 1967; Norton and Davis 1981; Edwards and Freebairn 1984; Scobie and Posada 1984). Furthermore, although Boserup argued the possibility of both labor and technology intensification, studies argue that labor intensive systems cannot obtain the production increases necessary to keep pace with Africa's fast growing population (Ruttan 1990). Capital-led intensification, intended as farm equipment, purchased inputs such as mineral fertilizer and soil and water conservation structures, are seen as the only way forward to avoid a crisis (Reardon *et al.* 1996; Reardon 1997; Breman 1998).

However, the use of equipment, fertilizers and soil and water conservation structures is low in Africa (Scoones and Toulmin 1999). Despite this, studies showing lack of degradation indicate that African farmers have been able to sustain large populations without the technological transformation envisaged by intensification theories. Burnham (1980), Dommen (1988), and Richards (1983, 1985) have argued that the management of various combinations and sequences of different landraces and crops is at the heart of the intensification that African farmers have been able to achieve. This implies that processes behind the intensification of many African agricultural systems are more complex than capital-led intensification theories are able to explain. There is thus a need to better understand the dynamics behind African agricultural intensification. Researchers, extensionists, and development workers increasingly, since the 1980s, have been re-examining the way in which technologies have been studied, developed, and extended.

2.2.2 *Indigenous knowledge*

The indigenous knowledge school (Brokensha *et al.* 1980; Richards 1985; Warren 1991) arose out of such re-examination of how agricultural technologies are treated. Indigenous knowledge refers to the knowledge that farmers have about their natural and social environment which they use to adopt, adapt and develop technologies to their local context. According to this school, the focus of research should be on trying to understand what farmers are doing and why they chose to do it in that way. These questions are at the center of how we approached the study of soil and water conservation technologies.

Indigenous knowledge gained attention in development circles in the 1980s when two collections (Brokensha *et al.* 1980; Howes and Chambers 1980) were published assembling research focused on the skill and rationale of farmers and pastoralists. These works were largely conducted by social anthropologists who drew from a tradition of studying indigenous knowledge to explain different aspects of "primitive" societies (such as Richards 1939; Fortes 1945; Bohannan 1954; de Schlippe 1956). The renewed interest in indigenous knowledge led to a rapid proliferation of such studies since the mid 1980s among different disciplines such as anthropology, agronomy, soil science, plant pathology, animal science, forestry, geography and mathematics (Asher and Asher 1986; McCorkle 1986; Prance *et al.* 1987; Furbee 1989; Nazarea-Sandoval 1990; Slikkerveer 1992; Tabor 1992; Toledo 1992; Bagayogo *et al.* 1994).

At first, in reaction to the emphasis given on scientific technologies in development circles, studies took a populist perspective and focussed on indigenous knowledge of technologies that were developed inside a community and passed down from generation to generation. This closed conception, however, soon gave way to a more dynamic concept of indigenous knowledge in which local knowledge is considered to be the product of local farmers interacting with external agents of change and adopting, adapting, and developing new technologies as a result. New conceptions address issues of power relations within a community or between local people and outside change agents (Scoones and Thompson 1994).

Two distinct approaches to indigenous knowledge have evolved (Fairhead 1992). The first focuses on understanding indigenous knowledge in order to compare and verify local agro-ecological beliefs and practices within the framework of western agricultural science. This approach aims to (a) evaluate indigenous knowledge, (b) bring indigenous knowledge and science together, and (c) empower local people by convincing scientists of the wisdom of indigenous knowledge through a scientific assessment of it (Fairhead 1992). This approach is characteristic of the majority of indigenous knowledge studies conducted since the mid 1980s including those on soils and soil and water conservation.

Studies on indigenous knowledge with regards to soil and water conservation in West Africa tend to focus on local soil classifications as well as descriptions of types of technologies used (Swanson 1979a; Dialla 1993; Schutjes and Van Driel 1994; Müller-Haude 1995; Reij *et al.* 1996). The classifications are useful for understanding if there are any equivalencies between farmers' and scientific categorizations of soils as well as pointing out some of the important characteristics of soils for farmers. The descriptions of technologies are also useful in developing technologies for similar geographic areas.

However these studies tend to produce static descriptions of a particular state of technology use. Both soils and technologies change over time making these studies eventually obsolete (chapter 6).

The second approach studies indigenous knowledge in order to question the assumptions of western scientific concepts and methods. According to this approach, methods and concepts reflect the history of the place where they are developed. Thus to understand the reasoning and justifications for local decisions, one must try to understand indigenous knowledge on its own terms, giving rise to new methods and concepts (see for example Hecht 1987; Norgaard 1987). The objective of this approach is comparative rather than evaluative in that it compares local and western agro-ecological interpretations (Thrupp 1989).

This study follows the second approach to indigenous knowledge for studying the technological aspects of soil and water conservation. That is, we study the technologies that farmers are using and how these have changed over time. Furthermore, while we use local soil taxonomies to help guide discussions with farmers as well as the sampling of soils, a larger part of our information collection efforts focussed on farmers' theories about soils. These theories give insights into how farmers perceive processes of soil formation and degradation as well as their own role as land users, in influencing these processes for worse or better. Furthermore, they provide insight into the local concept of soil fertility. Such local theories and concepts are important to understand some of the technical considerations farmers base their agricultural decisions on. They are also less time-dependent than soil taxonomies, because these latter may change in response to environmental change or the introduction of new crops due to their often practical orientation (chapter 6).

Stopping at the study of indigenous knowledge would leave an important area affecting agricultural performance unaddressed, that is, social institutions. Below we will see that even intensification theories such as those of Boserup and Hayami and Ruttan and their subsequent elaborations, make assumptions about the nature of institutions and institutional development that are necessary for their arguments about intensification to hold.

2.3 The role of social institutions

In Boserup's argumentation (see section 2.2.1), high population densities lead to technological intensification only when land tenure systems go from being feudal to private property based, transport and input markets are well developed as well as markets in which to sell the increased farm output. All of these changes will occur if population pressure is high enough.

Ruttan and Hayami's theory of induced innovation similarly relies on the workings of an "efficient" market system, in which prices are able to adequately adjust as a resource becomes scarce, in order to make it be valued more highly. Thus, in this case, the institutions of a market economy[11] provide the impulses that promote innovative activities.

[11] By market economy we mean an economy that functions according to neo-classical economic principles.

The part of the model which they term induced institutional innovation is an extension of the induced innovation model to institutions. As factor prices change and new technologies are developed, these create imbalances in existing institutional arrangements and new opportunities for institutional innovations arise. With this theory, the authors claim to be able to explain diversity in the way that institutions develop in different countries. As every country is endowed with a different set of resources, relative factor prices will be different thus stimulating different paths of institutional development. They further argue that factor markets will create "efficient" institutions. However, for this to be true, factor markets need to reflect changes in relative factor scarcities. Thus while the theory claims to be able to explain different technological and institutional development paths, it actually, implicitly, as does Boserup's theory, requires market institutions to develop and therefore assumes one, overarching, institutional development path.

These theories underlie much of the approach followed by economic studies of soil and water conservation technologies which have been among the most influential in formulating policies and interventions in this field. These studies typically look at two aspects: either they evaluate a technology (see for example Kaboré *et al.* 1994; de Graaff 1996; Erenstein 1999) or they analyze the conditions under which technologies will be adopted by farmers (see for example Clay *et al.* 1998). In both of kinds of studies, a market economy is presumed to be the dominant institution guiding allocative decisions. In the first kind of studies, technologies are evaluated according to income streams that they generate based on market valuation of costs and benefits. In the second type of studies, conditions in local economies are studied in order to determine what is hampering the diffusion of innovations (as usually these studies focus on the lack of adoption of technologies). Given the requirement of intensification theories of market institutions, recommendations from both type of studies focus on the need to redress market "malfunctions" such as missing markets, insufficient transport infrastructure, imperfect information and inappropriate policies. Solutions therefore aim at "getting institutions right" so as to behave more as they should in a market economy. In these analyses farmers' decisions are explained on the basis of being "rational" given imperfect market conditions.

Thus, when institutions are considered, they are government policies (or laws), research and development organizations and the market. The discussion of institutions is limited to those that make technologies and productive resources available (such as research and extension organizations, transport infrastructure) or accessible through money (such as credit markets, input and output markets, pricing policies). Furthermore, institutions are viewed as being along an evolving path towards a market economy. When institutions are not developing towards a "modern" or market economy, such as social institutions characteristic of African systems, they are deemed as detracting from productivity objectives (see for example Reardon and Vosti 1995). In this view, social institutions require resources to be spent on giving gifts, paying dowries, or conducting certain types of exchanges to build relationships with other people. These "investments" are seen as taking resources away from productive investments (Berry 1989), such as the purchase of a plow which would enhance agricultural productivity.

Studies by anthropologists focussing on agricultural production systems highlight how the social organization around production, not only in the visible form of research and development organizations, but also in the less visible norms, networks and inter- and intra-household relationships, can be just as influential on agricultural performance as the adoption and use of new technologies (Lewis 1981; Richards 1985; Berry 1989; Guyer 1992, 1997). Therefore studying local institutions can help illuminate some of the intensification dynamics of African agricultural systems that are still insufficiently understood.

2.3.1 Accessing technologies and productive resources

Although new approaches for studying soil and water conservation call for the need to look at access to resources (Blaikie 1989; Dietz 1996, 1999), Sen's (1981) entitlement approach was the first to bring the issue of access to resources into the policy arena and it provides a clear reasoning as to why accessing resources is so important in issues of land degradation.

Sen (1981) asked the question why famines can occur in the midst of food plenty. Dominant approaches to famine prevention and alleviation in the 1970s and 1980s focussed on aggregate food availability measures so that programs were activated once food per capita reached below a certain level. This approach, he argues, focuses uniquely on questions of availability but ignores the fundamental issue of how particular individuals and groups of people gain access to and control over food. The approach thus can explain only a portion of the famines that occur worldwide.

Sen focuses his analysis on the means with which people can access resources,[12] that is, entitlements. He defines entitlements as, "the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces" (Sen 1984: 497). Entitlements can be gotten through anything from market channels through which one can sell one's produce, to property right laws through which one can obtain the rights to use land.

Sen's analysis can be usefully applied to issues related to natural resources, such as land degradation and technology use (Dietz 1996). Just as with the food and famine debate, the environmental debate has been dominated by a focus on the quantity of natural resources available, giving rise to Malthusian interpretations of natural resource depletion. Similarly, we have seen that studies on technology use, adoption and diffusion have focussed on questions of the availability of technologies and one aspect of their accessibility: through money.

Extending Sen's analysis to issues of the environment points out that land degradation can occur not only due to an absolute lack of resources but also due to people's inability to access the resources that would allow them to derive their livelihoods in an environmentally sustainable way. Similarly, applied to the area of technology use, entitlement theory highlights that it is not only important to have technologies available that can help conserve soil and water, but also to have a social system that allows people to access technologies as well as resources in a non-depleting way. A corollary can be drawn from Sen's entitlement theory: a lack of degradation is not only an indication that resources and technologies are

[12] Sen uses resources similar to Harvey to mean "materials available 'in nature' that are capable of being transformed into things of utility to man [sic]" (Harvey 1974: 272).

available but also that people are able to access the resources and technologies that they need to derive their livelihoods in an environmentally sustainable way. In specific, for soil and water conservation, if we do not find signs of land degradation, it is not only an indication that people are doing the right things to the land in terms of using the right technologies or managing soils in the right ways but also that they are organized in such a way as to allow access to the resources and technologies needed for an environmentally sustainable cultivation of the land.

People's entitlements are what gives them access to resources and technologies. Entitlements are created, maintained, reaffirmed or destroyed through institutions. Sen focuses his analysis on legal and market institutions which create entitlements through official laws or prices, wages, and incomes. These are important forms of entitlements but are too restrictive for the context of this study, because there are other forms of gaining command over resources that go beyond the market and formal legal channels. In this study we have observed that resources may be accessed and controlled through kin networks, for example, and ways of legitimizing such access may fall within cultural norms and customary law. In subsequent work Sen (1984; Drèze and Sen 1989) develops the idea of extended entitlements that primarily relate to "the perceived 'legitimacy' of intrafamily distributional patterns" (Sen 1990: 195). Thus, although he extends the concept of entitlements, he broadens it only to intrafamily ties, still excluding broader institutions such as kin networks and cultural norms.

It has become apparent from the discussion thus far, that to study the use of soil and water conservation technologies, it is necessary to include an analysis of institutions that allow access to technologies, as well as access to resources that are needed for an environmentally sustainable cultivation of land (chapter 8). We have also argued the need to study institutions in the broad sense, to include organizations such as agricultural research and extension services, but also social institutions such as kin networks and cultural norms. None of the theories discussed thus far elaborate on how institutions should be studied. In fact, we have seen that often institutions are merely assumed to develop according to a given path. We therefore discuss below theories that specifically deal with institutions so that the way in which institutions develop is the focus of study rather than assumed.

2.3.2 Institutions, allocative decisions, and the cultural economy

One of the questions that we are concerned with, why are farmers using certain types of technologies and not others, is an economic one in that it is concerned with the allocation of productive resources.[13] Why do farmers choose to invest in certain things and not others? Or, alternatively, why do they use their resources in certain ways and not others? However, as argued at the beginning of this section, economics as a discipline has either ignored the role of institutions in decision making by treating them as exogenous factors, or to the

[13] In this study we use the term resources to refer not only to what Harvey (1974) calls resources available "in nature", but also to what farmers are endowed with, and which they can use for productive purposes. Examples are labor, land, money, and technologies.

extent that they are taken into consideration, by evaluating them against the backdrop of a market economy.

New Institutional Economics (NIE) is a branch of economics that arose in trying to address the lack of attention of institutions within the economics discipline. North (1990), one of the founding fathers of NIE, argues that efficient markets will lead to maximum aggregate income, a condition stipulated by neoclassical theory, only if bargaining is costless and information is fully available. When it is costly to bargain and to obtain information, it becomes costly to transact. And when it is costly to transact, institutions matter. In most everyday situations transaction costs are involved. For example, if two parties are bargaining, and one knows more than the other, the latter needs to engage in monitoring and information search activities in order to minimize her loss. These activities are costly and as such create transaction costs.

NIE studies institutions through transaction costs. Institutions are broadly defined by NIE to comprise more than just official organizations. Institutions are seen as "the humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g. rules, laws, constitutions), informal constraints (e.g. norms of behavior, conventions, self-imposed codes of conduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies" (North 1994: 360). Simply put, institutions are both the formal and informal rules guiding people's behavior. Transaction costs are those costs associated with enforcing these rules: punishing offenders, keeping people away from accessing certain resources or conversely, making the resources available to them. The lack of information constitutes another type of transaction cost: the difference in knowledge between people means that there are costs associated with communicating and sharing information. Thus through studying transaction costs, one gains an understanding about how institutions function.

Despite these steps forward that NIE has made with respect to making the a-social *homo economicus* of neo-classical economic theory into a social being, it falls into the same pattern that characterized Boserup's and Ruttan and Hayami's theories. That is, NIE leaves very little room for institutions to develop and function in a "non-western", market style fashion. As Platteau (1992) points out, NIE essentially treats transaction costs as dependent on *objective* elements of the techno-economic environment. "Transaction costs are generally considered to be independent of the ruling system of norms and values which determine the degree of legitimacy and acceptability of particular arrangements in the eyes of the participants" (Platteau 1992: 34).

In relation to the assumption of how land rights will evolve that are inherent in both Boserup's (1965, 1981, 1987) and Hayami and Ruttan's (1985) arguments as well as in subsequent elaborations of the latter (Pingali and Binswanger 1986; Binswanger and McIntire 1987; Ruttan 1987), Platteau (1992) points out that cultural norms and customary laws may make a private property rights regime a form of property rights with the highest transaction costs. If local populations perceive that land belongs to their ancestors and they have gained rights living on the land and cultivating it for generations, then the imposition of private property rights will lead to deep-seated feelings of injustice. Any sort of resistance that this engenders will create high transaction costs of trying to keep the original inhabitants out. Likewise, the strong emotional identity links with the land and with being a "good" farmer, may be more effective incentives for conserving land than market prices in a context in which market mechanisms are treated with suspicion.

Another and more fundamental criticism of the NIE approach is that it remains within the orthodox economic paradigm in that it is largely concerned with equilibrium analysis and efficiency outcomes. This is part of the deductivist method that links NIE with orthodox economics (Pratten 1997). The deductivist method leads to considering the institutional environment in which transactions take place as a "shift parameter" (Williamson 1993, cited in Pratten 1997). In other words, changes in the institutional environment will change the conditions under which certain transactions are profitable which in turn change the types of transactions that people opt for. Transaction costs thus for NIE are what prices are in orthodox economics. For this to hold, NIE needs to make similar behavioral assumptions about the economizing individual as does orthodox economics. NIE "has the same representative rational individual marching into one kind of contract or refusing to renew it and entering another kind for the same set of reasons, namely, the cost of transactions in a given economic environment" (Douglas and Isherwood 1996).

While we do not argue against the notion of rationality, we take the view expressed by the anthropologist Sahlins (1976) and used frequently in anthropological literature, that rationality is locally situated. That is, local institutions determine what makes sense within a given society. Therefore, in order to understand farmers' decisions regarding soil and water conservation technologies, it is fundamental to study the local institutions that guide their decisions. The approach of this book thus, gives a much more central role to culture, mores and values in affecting economic action than does NIE.

The fact that we use the concept of embedded rationality, however, does not mean that we adopt the substantivist view in anthropology in which a clear split is made between the unique character of African economies guided by reciprocity, solidarity, and mutual assistance (see for example Polanyi 1944; Scott 1976; Hyden 1980) and the individualistic, profit-seeking morals of a capitalistic system. Rather we approach the subject by looking at how the two systems mix as a result of local histories and cultures.

Socio-anthropological literature is interested in understanding African institutions on their own account rather than compare them with an ideal or "efficient" model as is often implicit in economic analyses. While economists see institutions as arising due to imperfect or missing markets (see for example Platteau 1991: 124-125), social anthropologists treat social institutions as key factors determining the organization of economic activity. Because social institutions are such a pervasive feature of African communities, they require a reconceptualization of our theories and methods of analysis (Berry 1993).

In order to have a framework that would allow for alternative paths of institutional development we turned to recent socio-anthropological studies of African institutions that affect systems of production (for example Shipton 1989; Berry 1993; Guyer 1997). Although these recent studies do not focus specifically on soil and water conservation technologies, their approach to the study of agrarian change is helpful in understanding the dynamics of the use of soil and water conservation practices because they focus on understanding farmers' rationales through their particular socio-cultural and economic histories. These studies, therefore do not focus on finding a western equivalent for categories or concepts, and they also do not superimpose western systems on the functioning of African systems. These studies look at local institutions and through them analyze the way in which social systems affect and are affected by agricultural change. Berry suggests analyzing agrarian change by "tracing changing uses of agricultural surplus, at all levels of social agency, and analyzing the ways in which they have shaped and been influenced by conditions of agricultural production and linkages between agricultural and non-agricultural sectors of African economies" (Berry 1984: 60). Social, economic, and historical processes are given a central place in the analysis.

In this study we trace the changing uses of agricultural surplus through people's transactions. Transactions have multiple meanings even in societies where the market has a large influence on people's daily lives. Mauss' (1990) work, first published in 1925, on gifts showed how exchanges of goods, services, or money between people create relationships between those engaging in an exchange. Even as societies become more integrated into market economies and transactions become increasingly commercialized, transactions continue to have multiple meanings and to establish social relationships (Kopytoff 1986; Berry 1993). Guyer (1997) shows how a farm economy can be commercial without being capitalist. Thus, although markets come to have an increasing influence over people's daily lives, it should not be assumed that markets will develop according to the precepts of neo-classical economics. Rather, being filtered through local histories and cultures, they will form a local economy with its own "rules". This local economy is what we call the cultural economy.[14]

The characteristic that distinguishes the cultural economy from other similar terms such as Hyden's (1980) "economy of affection" is its quality of a *mixed* system. Thus the cultural economy does not imply, as does the economy of affection, that there is an "uncaptured peasantry" that has remained impermeable to market forces. Rather it emphasizes that a local economy is embedded within a socio-cultural system, but that it interacts within a global context, and as such, is continuously transformed. The focus is thus not on the internal harmony of a closed economic system, but rather on how social and market principles mix as a result of the interactions between a system and its social, economic and physical environment (chapters 7 and 8). At the same time, the concept of cultural economy is different from the generic term economy, as it is normally treated in economic studies. In these latter, economy is used to mean a market economy or a "wanting" market economy. The concept of a cultural economy instead implies that a market economy will always be filtered through a society's socio-cultural and economic histories. Thus, in essence, pure market economies do not exist as every economy is a cultural economy.[15] Our choice of using a special term for it is not in the interest of coining a new term, but rather in making a distinction between these various approaches to treating economic systems.

[14] Term borrowed from Shipton (1989).

[15] Ironically, sociological and economic studies on the theory of the firm are more advanced in showing the interplay of pure market economic principles with firm culture in affecting the way firms develop (Dosi and Egidi 1991; Teece and Pisano 1994; Chapman and Buckley 1997; Callon 1998; Granovetter and McGuire 1998) than are studies on developing economies.

2.4 Summary: a framework for the study of soil and water conservation

This chapter has presented the theoretical elements that support the framework behind this study, by running through the most influential theories guiding soil and water conservation studies and explaining what we used, adapted and rejected of these theories. By way of summary, we present the framework referring to the chapter(s) that deal with specific aspects.

Similarly to recent developments in cultural geography (Duncan and Ley 1993), social anthropology (Guyer 1996; Guyer and Richards 1996) and "new ecology" (Scoones 1999), we treat landscapes as emerging out of the interaction between social and environmental histories. Consequently, the analysis in part 2 of the book pays particular attention to local environmental, social and economic histories.

Stories of land degradation in the research area are treated, as is argued by recent literature (Blaikie 1985; Roe 1991, 1995; Leach and Mearns 1996), as narratives and are therefore questioned. This is done by analyzing for the country, research area, and study villages the very data and indicators on which the narratives are built (chapter 5). The emerging picture is then explained in the chapters that follow, in terms of the technical as well as the social means through which people use the land and how these are grounded within a local history (chapters 4, 6, 7, and 8).

Theories of technological intensification provide the reasoning behind the large number of studies that call for capital-led intensification as the way to increase productivity to keep pace with Africa's rapidly growing population and maintain environmental sustainability (Reardon *et al.* 1996; Reardon 1997; Breman 1998). However, capital-led intensification, of the kind envisaged by such studies, is very limited in Africa. The indigenous knowledge school, instead, draws attention to the fact that farmers have other means of intensifying production and are constantly developing, adapting, adopting and diffusing technologies as a result of the mere fact that they need to make a living by cultivating in dynamic environments (Richards 1985). Chapter 6 analyzes technologies from an indigenous knowledge perspective by focussing on those technologies that farmers use and the theories they have about soils, soil formation and degradation processes, and their role within these processes as users of the land.

Following the view set forth by social anthropologists (Berry 1993; Richards 1993; Guyer 1997) that agricultural performance is influenced by social institutions as well as technologies, chapters 7 and 8 focus on the social management of production. Anthropologists argue the need to study the economy through local logics (Sahlins 1976; Shipton 1989; Guyer 1997). Chapter 7 analyzes the cultural economy by focusing on local concepts that guide economic action that result from the interaction of a local culture with broader environmental, social, and economic trends. These local logics are not seen in terms of characteristics of a traditional system, but rather as the particular mix of principles that results from increased market integration being filtered through a local culture. Sen's (1981, 1984, 1990) entitlement approach, applied to environmental issues highlights the importance of access to resources in affecting the productivity and environmental sustainability of a system. In light of the economic principles that emerged from the analysis of the cultural economy, chapter 8 then looks at how social institutions can contribute to environmentally sustainable land use by providing access to resources.

Looking at soil and water conservation in this integrated way, we aim to understand the dynamics that underlie an African agricultural system by linking the physical characteristics of a farmer's field, what farmers do to the soil, how they organize themselves within a community, and the landscape that emerges as a result thereof (chapter 9).

Finally, in the conclusion to the book, we come back to the elements of the framework presented in this chapter and, based on the analysis in part 2 of soil and water conservation in eastern Burkina Faso, draw wider theoretical implications for the study of soil and water conservation in an African context.

3. Research methods

Even in prison they would not ask you so many questions.
(Djalambiga Lankoandé, Samboanli,1997)

In the introduction, the complexity of soil and water conservation in the African context was highlighted, as well as the necessity to find new ways of studying soil and water conservation. In chapter 1, the groundwork was laid for an alternative, interdisciplinary, and open approach to soil and water conservation research, while chapter 2 developed the necessary analytical framework. In each case, it was pointed out that soil and water conservation should be addressed from multiple perspectives, each requiring a variety of disciplinary and interdisciplinary research methods, some of which, at first sight, seem only faintly related to the topic of soil an water conservation. This approach asked much time and patience of the villagers with whom we worked, eliciting comments such as the one cited above. This chapter is dedicated to those research methods and as such gives insight into the empirical foundations on which the analysis in part 2 is based. Reading this chapter is not a prerequisite in order to understand the remainder of this book.

The chapter begins, in section 3.1, with a discussion of how research area, research villages, and research assistants were selected. Section 3.2 presents a time-line of the different research activities and shows who carried out which activities. Section 3.3 presents methods used for national and regional level inquiries. This is followed by section 3.4 on village level studies. Finally, section 3.5 deals with the research methods that were used as part of the embedded case studies of individuals discussed in chapter 1.

3.1 Setting-up the study

3.1.1 Selection of the research area and the research villages

The project was carried out as part of the Aménagement et Gestion de l'Espace Sylvo-Pastoral au Sahel (SPS) research program of the Université de Ouagadougou and the Wageningen University and as such was conducted in Burkina Faso. As part of this project, a joint outreach station in Ouagadougou, the Antenne Sahélienne, supplies material and scientific backstopping for Wageningen University researchers during their work in Burkina Faso. While most of the Wageningen researchers work in Sanmatenga and Zoundwéogo provinces, it was not clear whether they were the appropriate locations for this project. Both provinces have a large number of development projects (e.g., the large Dutch integrated rural development projects PEDI and PEDI-Z) that are active in the field of soil and water conservation. Given the fact that the present study is interested in what farmers do on their own accord, without incentives offered by projects, it was felt that a high intervention level might complicate research. Present soil and water conservation interventions might hide the real preferences and attitudes of the farmers (see also the discussion on the development discourse in chapter 1). A rapid appraisal was carried out not to exclude these provinces a priori and also to investigate alternative locations.

A rapid appraisal

The rapid appraisal was carried out during the 1994 rainy season and covered six provinces: Sanmatenga, Gourma, Gnagna, Tapoa, Soum, and Yatenga provinces. In each of these provinces two or three villages were visited. The villages were selected in concert with the local extension service or an NGO that also introduced us to the villages. In order to avoid the development discourse as much as possible, it was pointed out that we wanted to visit villages that received no current support from development projects and were not receiving special attention from the extension service. This criterion was not always fully met, as in some areas, such as the Yatenga province, it was hard to find villages without current interventions.

Structured group interviews were conducted in each of the visited villages during which villagers were asked about the principal problems experienced in agriculture, the local soil and water conservation practices, and their history. This was followed by short field visits in which farmers pointed out the practices that had been mentioned during the meeting and further questions were asked.

The rapid appraisal highlighted that the repertoire of local soil and water conservation practices was largely identical in all of the visited provinces (with the exception of the *zay* planting-pit technique encountered only in the Yatenga). It also became clear that processes such as population growth, increased livestock ownership among farmers and increased cultivation of bottomlands were found throughout the provinces, as well as the kind of problems mentioned by farmers such as erosion, impoverishment of soils, etc. These things being equal, there was a remarkable difference between the villages in terms of how they spoke about these issues. In the provinces on the Central Plateau, with their high intervention level, the villagers showed an attitude of awaiting development interventions rather than take initiative to tackle their own problems. This attitude prevailed in both the villages that received interventions and those that did not receive any interventions. In the eastern region this was much less the case. While some villages shared the wait-and-see attitude found on the Central Plateau, other villages had a much more dynamic attitude and did not only focus their discussions on the lack of agricultural equipment and external help.

Selection of the research area

The selection of a research area took place based on the following criteria:

1. Presence of local soil and water conservation practices.

2. Presence of dynamic social and environmental processes affecting soil and water conservation practices.

3. Relatively low current intervention level.

4. Having villages with different population densities and rainfall levels.

5. Good accessibility during the rainy season.

The first two criteria, the presence of local soil and water conservation practices and the presence of dynamic processes of change affecting those practices, are fundamental in any study on local soil and water conservation practices and how their use changes over time. Both of these criteria were equally met in all of the provinces visited during the rapid appraisal. The third criterion, low intervention level, was important to be able to observe what farmers used as soil and water conservation technologies on their own initiative. This criterion was best met in the provinces of the eastern region, which has one of the lowest intervention levels of the country. The fourth criterion, having villages with different population densities and rainfall levels, was important to be able to study the influence of these factors on land use intensity and degradation risk. This criterion was best met by a combination of Gnagna and Gourma province in the eastern region because they are at a manageable distance from each other given our limited time and resources, while at the same time different from each other in terms of population pressure. The dry, densely populated Gnagna province and the wet, sparsely populated Gourma province provide a strong contrast in terms of land use intensity and the potential for land degradation. The fifth criterion, good rainy season accessibility, was important to be able to carry out fieldwork during the rainy-season without the risk of getting cut-off from the medical services in the capital Ouagadougou. This criterion was met for all visited provinces except Soum. As especially criteria three and four were best met in Gnagna and Gourma provinces of the eastern region this area was selected as a research area (see map 1). Initially Tapoa, the third province of the eastern region, was also considered, but the distance from the regional capital Fada N'Gourma, which was selected as our base, did not permit its inclusion (see map 2).

Selection of the research villages and the research population

For the selection of the research villages the same criteria were applied as those for the research area. An additional criterion, however, was that we wanted to select villages with the same ethnic majority to exclude cultural differences as a factor affecting the use of soil and water conservation. Based on these criteria, exploratory visits to 26 villages within a 120 km radius of Fada N'Gourma were made (Niemeijer and Mazzucato 1995). In each case, we were formally introduced and accompanied by someone from the extension service or a local NGO. Where possible, villages were notified in advance of our arrival, out of politeness, and to allow them to gather together a group of men and women to speak with us. During group interviews information was collected on whether it was a recently established village or not, the ethnic composition of the village, the cultivated crops, the frequented markets, and the soil and water conservation practices. In addition, some information was collected on nearby villages to determine if they would be of potential interest for an exploratory visit.

The group interviews in these 26 villages provided us with a better understanding of the history of the area and the processes of change. At the same time they formed the basis on which we were able to select our research villages (Niemeijer and Mazzucato 1995). Five villages were finally maintained for that purpose (see map 3). Initially we intended to work in four of them (two in Gnagna and two in Gourma province) while the fifth (in Gourma province) was retained as a secondary research village in which a student could work. Two of the four villages, one in Gnagna and one in Gourma province were selected as main research villages: Samboanli in Gnagna province with a high population density and low average annual rainfall, and Pentouangou in Gourma province with a low population density and higher average annual rainfall. In these villages all research activities would be carried out, while the other two were to be studied less intensely. The idea of this setup was that by looking at multiple villages we would be able to distinguish between general patterns in the region and individual characteristics of the research villages. At the same time, the contrast between the villages in terms of the pressure on natural resources would provide insight into the process leading to land degradation or its prevention. The two main research villages and three secondary research villages are discussed in detail in chapter 4.

After some initial participatory research activities (section 3.4.1) in the four research villages, we had to abandon work in the secondary research village in Gnagna province because an old conflict was aggravated by our presence. After the second fieldwork period we also had to abandon the secondary research village in Gourma province because the death of the village chief caused dissension among some of the village wards and we did not want to be caught in between. The loss of these secondary research villages was unfortunate but it did allow us to focus in greater depth on the two remaining villages. Furthermore, sufficient work had been done in the secondary villages before they were dropped, so as to have some of the benefits of having worked in multiple villages.

In all research villages Gourmantché compose the majority ethnic group. While certain research activities were done with all of the ethnic groups, the focus has been on the Gourmantché population. This choice was made for several reasons. Focussing on a single ethnic group allowed a more in-depth study than including all ethnic groups would have allowed for. Gourmantché were the most logical choice for a study on soil and water conservation, because, compared with Fulbe, they engage most heavily in arable farming. In addition, as Gourmantché form the majority of the population in the eastern region, studying them makes the study most representative for the region. Since the Gourmantché farming practices are not so different from those of the Mossi, who region-wise are an important minority and nationally form the country's major ethnic group, the study can also be representative for certain Mossi regions.

A focus on the Gourmantché does not mean other ethnicities were ignored. In fact, an important part of our inquiries were aimed at understanding the interaction between ethnic groups and how this affected agriculture in general and the soil and water conservation practices of the Gourmantché in particular. The relations with the Fulbe and Rimaïbè were found to be important for an understanding of the livelihood patterns of the Gourmantché (chapters 7 and 8). To gain a better insight into these relations from both the Gourmantché and Fulbe/Rimaïbè perspectives, the Fulbe and Rimaïbè in both main research villages were studied for the duration of one year by an assistant, who himself is a Fulbe (section 3.4.3).

3.1.2 Selection of research assistants and interpreters

The approach to this study places great emphasis on the establishment of a rapport of trust between researchers and villagers (chapter 1). Considerable attention was thus given to the selection of research assistants/interpreters because our relationship with villagers would be filtered through the words, gestures, and attitudes of our interpreters. Some 15 candidates were invited for an interview. Based on these interviews a sub-selection of three women and three men was made for actual field tests. Applicants were taken along to one of the 26 villages that were visited during the village selection phase (section 3.1.1) and were asked to do some of the interpretation work. Upon return we would ask the field agent that had accompanied us for his impressions and combine this with our own observations of the interpretation work. In some cases we took the same applicant for a second time to a village. We finally selected one woman and two men to work for us.

Important in the selection process was fluency in French (oral and written) and good command of the two most important local languages Gourmantchema and Mooré, as well as fluency in both of the local dialects of the former language, as in one of the main research villages one dialect was spoken and in the other village another. Just as relevant, however, was the attitude of the applicant towards the village population. We wanted people with whom the villagers would feel at ease, in other words, that would not act as though they were above them, or refuse to eat what the villagers offered them. In practice, this excluded the candidates who had not had any experience living in a village. It also excluded the few applicants who had a partial university education, because of the attitude that tends to come with this status.

While we started off with three field assistants, we later employed a number of other assistants for work done outside the villages such as on data-entry, transcription of taped interviews and carrying out market surveys. A fourth field assistant was hired during the last year of fieldwork and, starting in September 1996, we hired a university trained Fulbe assistant for just over a year.

3.2 Time-line of research methods

As a substantial number of different research methods were used at various phases of fieldwork, it is useful to present them in a time-line. Research was carried out by ourselves, our research assistants, six students from several Dutch universities, and in one case by villagers. Table 3.1 indicates for each research activity when it was carried out and by whom.

The initial phase consisted of the selection of the research area (section 3.1.1). The exploratory phase, which took one year, began with the selection of the research villages (section 3.1.1) and some exploratory surveys.It was also during this period that a social anthropology student did her MA fieldwork in one of the secondary research villages (see

Table 3.1 Research method time-line

Year	1994					1995												1996												1997												1998		
month	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Fieldwork phase	Initial phase							Exploratory phase													First agricultural season												Second agricultural season											
Field presence of researcher(s)																																												
Field presence of researcher(s)	R	R						R	R	R	R					R	R	R	R	R						R	R				R	R	R					R					R	
Research area and village selection (section 3.1)																																												
Rapid appraisal for area selection	R	R																																										
Exploratory survey for village selection									R	R																																		
National and regional level inquiries (section 3.3)																																												
Time-series and cross-section analysis										R																																	R	
Archival research[a]															R			R	R	S	S	S	S				S	S	S			R		A								A		
Development intervention studies																																S	S	S	S	S								
Village level studies (section 3.4)																																												
Participatory research										R	R					R	R	R	R																									
Exploratory village census												A	A	A	A																													
Population census																					A	A																						
Village survey																					A	A																						
Exploratory market survey												A	A	A	A	A	A																											
General market survey																				A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Price allocation study																						A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A							
Technology survey																																	A	A	A							A	A	
Interviews and conversations	R	R						R	R	R	R	S	S	S	S	R	R	R	R	R						R	R				R	R	R					R					R	
Oral village and life history interviews																R	R	R	R												R	R	R											
Observation	R	R						R	R	R	R	S	S	S	S	R	R	R	R	R						R	R				R	R	R					R					R	
Assistant reports										A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

Continued on next page

Table 3.1 – ***Continued***

Year	1994					1995												1996												1997												1998		
month	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Fieldwork phase	Initial phase							Exploratory phase													First agricultural season												Second agricultural season											
	Village level studies (section 3.4)																																											
Research on the Fulbe																										A	A	A	A	A	A	A	A	A	A	A	A							
Changing land use study																															R	S	S											
	Case studies of individuals (section 3.5)																																											
Budget diaries																					A	A	A	A	A	R	R	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Stock study																													A	A		A	A	A	A	A	A	A	A	A	A	A	A	
Exploratory time allocation study												A	A	A	A																													
Time allocation study																						A	A	A	A	A	A	A	A	A														
Cultivation history interviews																															R	R	R											
Agricultural questionnaire																					A	A	A	A	A	R	R	A	A	A	A													
Yield measurements																								A	A	R	R	A	A	A						A	A	R	A	A	A	A		
Soil sampling and soil profile description																										R	R						R					R	A					
Rainfall measurements																							V	V	V	V	V					V	V	V	V	V	V	V	V	V				

Note: Activities are marked with letters to indicate by whom they were carried out: R = researchers; A = research assistants; S = students; V = villagers. Where a researcher or student carried out an activity this was always in conjunction with an assistant. Only research activities in Burkina Faso are covered in this table, but see note (a) below.

[a]Archival work was also carried out in France and Niger.

Wolffenbuttel 1997). The second part of the exploratory phase was concerned with getting to know the main research villages through participatory work, oral historical and life history interviews, through group interviews on agriculture, and through observation and informal conversations (sections 3.4.1 and 3.4.3). During this phase the archives at the Prefecture of Fada N'Gourma and the CNRST in Ouagadougou were visited on the basis of which two archival research projects were defined for students (section 3.3.2). Towards the end of the exploratory phase questionnaires were designed and tested for more quantitative survey research (section 3.4.2) and a number of case study individuals were selected (section 3.5.1).

The next phase, with a duration of a full year, covered a first agricultural season during which a number of market and village surveys were carried out (section 3.4.2) as well as quantitative and qualitative work on case studies of individuals (section 3.5). During this phase research by a Fulbe research assistant on the Fulbe and Rimaïbè population of the two main research villages also started (section 3.4.3). Observation, conversations and interviews continued to take place. It was also the year in which two students carried out their archival research (3.3.2).

The last phase, also one year, covered a second agricultural season. The market surveys (section 3.4.2) continued during this phase. New were a technology survey (section 3.4.2) as well as a study on changing land use that was based on aerial photos and fieldwork and largely carried out by a student (section 3.4.4). During this period two other students collected material on interventions in the agricultural sector by governmental and non-governmental organizations (section 3.3.3).

During most of our own fieldwork we visited the main research villages alternately for periods lasting one day up to 4 to 5 days in a row. In the latter case we lived in the compound of the village chief. During our absence the field assistants alternated their work on a biweekly basis between the two main research villages, staying in one village for four to five days in a row. This way they were able to be in each of the villages every other week, limiting the amount of information that villagers needed to give on recall. During our absence weekly reports were written by the assistants about their experiences and observations that we received by mail (section 3.4.3). Many of these reports contained valuable information, not only on the progress of their work but also on observations and conversations relevant to our work. During the last two years also bi-weekly faxes were exchanged to keep better track of the problems the assistants encountered in the field, allowing us to respond in a more timely fashion.

3.3 National and regional level inquiries

A number of research activities were conducted to collect data at the national and regional levels in order to place the results of the village level research in a wider context. These data are used throughout part 2 of the book, but especially in chapters 4 and 5.

3.3.1 Time-series and spatial analysis

Population, rainfall and yield trends play an important role in any discussion on land degradation and therefore on soil and water conservation. Both time series, as well as cross-section data, were collected for each of these trends at the national and regional level.

Time series

Human and livestock population time-series data were obtained from colonial reports (section 3.3.2) and post-colonial national censuses and livestock statistics (see chapter 4 for a discussion of these time-series). For the analysis in chapter 5, use was also made of population estimates of the FAOSTATS statistics database (FAO 2000). Rainfall data were obtained from the internet (ADDS 1998c) and from the national meteorological service in Ouagadougou. The time-series of agricultural statistics, such as yields, harvested areas, and agriculturally active population that are used in chapter 5 were derived from national and regional level annual reports of the ministry of agriculture and the FAOSTATS statistics database (FAO 2000).

Spatial analysis

For the spatial analysis of the relation between population pressure and agricultural productivity discussed in section 5.4.3 of chapter 5 more detailed, provincial level data were collected for the mid 1990s. The following variables were used for this analysis: rural population size, agriculturally active population, actual provincial area available for cultivation, agricultural statistics on production and cultivated area, long-term rainfall averages, livestock numbers, and technology ownership and usage. The sources used and the computations involved in each of these will be discussed below.

Figures for the 1993 rural population size were based on MARA (1996a), which gives the agricultural population for 1993 based on an extensive national agricultural survey.[16] For practical purposes rural and agricultural population figures can be considered comparable for Burkina Faso (MARA 1996a: 24). Figures for the agriculturally active population in 1993 were derived from MARA (1996a), by taking the population with arable farming as primary activity during the rainy season. Arable farming as secondary activity during the rainy season (an average 2% of the agricultural population) was not included to avoid double counting as from the data (MARA 1996a: Tables A73 and A76) there is clearly an overlap between crop production as primary and secondary activity.

More complicated was the determination the area available for cultivation for each of Burkina Faso's thirty provinces. Total provincial area tells very little about actual population pressure on resources as certain areas are not available for cultivation because they are used for construction (towns), covered by water (lakes), reserved for nature (national parks and reserves), or uncultivable because of unsuitable soils and steep slopes.

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[16] The rural population figures from the latest (1996) census could not be used because this, unlike all other available data, follows a new administrative division (see section 4.1).

No information could be found on the spatial distribution of the 0.7% of the country that is covered by water (MET 1991). Likewise no provincial level information was available on land suitable for agriculture, which, as has been pointed out for other parts of Africa (Binswanger and Pingali 1987; Lele and Stone 1989; Matlon 1990; Niemeijer and Niemeijer 1995), may lead to an underestimation of population pressure, because a considerable part of the land is actually not suitable for cultivation. Using the 1:1,000,000 tourist map from IGN France and with some corrections data from MEE (1996), it was possible to determine the protected area per province. A little over 8% of the country is unavailable to cultivation because it is protected.[17] A further complication was that the administrative maps provided by the national geographic institute (IGB), the IGN tourist map, the vector data available through ADDS (1998b, 1998a), and the provincial areas supplied by the national demographic institute (INSD 1996) did not match. For as many as eleven provinces, differences between the various sources were 5% or greater. In some cases the INSD data varied by a factor 0.6 to 2.7 from the ADDS data. After a comparison of the various maps and sources, it was decided to calculate provincial areas based on the ADDS vector data (with some corrections[18]), because these boundaries are most consistent with the more detailed administrative maps and do not result in unlikely population densities as some of the provincial areas from INSD (1996) lead to. It may be comforting to know that despite the observed inconsistencies the different provincial areas do not lead to dramatically different results in the further analysis.

For the agricultural production statistics averages were used over five years. This was to compensate for the effects of year to year differences in rainfall amount and distribution on cultivated areas and yields. For this purpose the years 1993 through 1997 were chosen, as for these years the most reliable province level data were available (MARA 1995b, 1996a, 1996b, 1997b, 1998). In 1993, MARA carried out a large-scale agricultural survey with a centralized methodology and a stratified sampling approach, which in a first phase collected information for eight households in over two thousand villages. During a second phase measurements were taken in a sub-sample of over one thousand villages producing data on almost nine thousand households (MARA 1996a). In the following years the same methodology was applied but with (depending on the year) a sub-sample of some 500 to 800 villages and four to six thousand households (MARA 1995b, 1996b, 1997b, 1998).

Production statistics for all major annual food crops (millet, sorghum, maize, rice, fonio, cowpeas, Bambara groundnuts, yam, sweet potato, groundnuts, sesame, and soya) were used. All of these crops are grown for consumption and to some degree also for the market. Cotton was the only major crop that was excluded from the main analysis because it receives important quantities of fertilizer and therefore does not give a good indication of the "natural" productivity of the land. Per province, averages (over the five studied years) were determined for both the area and the production of each of the crops. In order to

[17] The very large "réserve sylvo pastorale et partielle de faune du Sahel" (16,000 km^2) was not taken into account as the area is inhabited and used for agriculture. This may in practice also be the case in some of the smaller protected areas but no details were available on the actual use of these areas.

[18] These consisted of attributing the department Loropeni to Poni province and the department Kando to Kouritenga province (Jan Piet van der Mijl, personal communications).

combine the production of all the crops into a single production figure per province the figures were all converted to their energetic value (based on Woot-Tsuen Wu 1968; Euroconsult 1981, 1989). This is an important step because some crops such as yams and sweet potatoes may yield as much as 5 to 10 thousand kilogram per hectare which seems a lot compared to, for instance, sorghum with only 800 to 1200 kilogram grains per hectare. This difference is, however, mainly due to a different moisture content. To determine labor productivity this energetic value was divided by the agriculturally active population corrected for the proportion of the cultivated land that is used for food crops (as a proxy for the amount of labor dedicated to food crops and not cotton). For land productivity the energetic value was divided by the total cultivated area minus that of cotton. This implies that any conclusion on land or labor productivity in terms of energy production concerns only the land used for food crops and thus does not permit a conclusion on the state of the soil of the land used for cotton. To verify whether the inclusion of cotton would lead to different results an alternative analysis was done on the basis of conversion of production figures to dry production[19] (based on moisture content data from Woot-Tsuen Wu 1968; Euroconsult 1981, 1989), rather than energetic value thus permitting the incorporation of cotton.

Long-term average annual rainfall per province was calculated by averaging for each year the annual rainfall of all the long-term rainfall stations in a province[20] and then calculating an average for the years 1956 to 1998. A total of 125 rainfall stations were used in these calculations. Minor stations were excluded because they tend to be unreliable and their record is often only sporadic. Data were derived from ADDS (1998c) and the national meteorological service.

Livestock numbers were determined by averaging data from 1993 and 1994 derived from MARA (1994a, 1995a) and converted to Tropical Livestock Units based on Williamson (1978). Finally, data on agricultural technology ownership and usage were all derived from MARA (1996a).

3.3.2 Archival research

Archival research had several purposes. It provided a source for triangulation with oral historical and life history interviews (section 3.4.3), it provided information on colonial policies affecting agriculture and, finally, it provided material on general developments in the region such as human and livestock population growth. Several archives with colonial material on eastern Burkina Faso where visited during the course of this study: The Centre des Archives d'Outre-mer of the French National Archives in Aix-en-Provence, the archives of the Conseil National pour la Recherche Scientifique et Technologique (CNRST) in Ouagadougou, the Niger National Archives in Niamey, and the archives at the Préfecture in Fada N'Gourma. Material in these archives were studied by ourselves and in the case of

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[19] The term dry production is used instead of dry matter production because the latter often refers to the total produced plant material not just the harvested grains or roots.

[20] For two provinces (Passoré and Sanguié) a correction was made by including some stations from a bordering province because the stations within the province were distributed unequally.

the CNRST and Préfecture also by two students (see Zuurd 1996; Lutgendorff 1997). In addition, some material in the archives in Niamey and Fada N'Gourma were processed by assistants.

The archives at the Préfecture in Fada N'Gourma were in very poor shape when we first went there. None of the material was organized and a considerable part of it was located as one large heap of documents and papers in a dusty room full of insects, rodents and snakes. Together with the prefect, we drew up a project to restore the archives. This project was funded by the Dutch Embassy. Two students and one assistant reorganized this archive and photocopied documents that were going in disarray such that the material is now coded and accessible. Some of this work was also done for the archival material at the prefectures in Bogandé, Diapaga and Pama. An index to the archives of these four prefectures is now available at the prefecture in Fada N'Gourma (Traoré 1998).

When working with colonial archival material it is important to be aware that there are political motivations that color the information that is given in the colonial reports (Gervais 1990). A Commandant de Cercle often had good reasons to present certain situations as worse or better than they really were or to simply ignore certain facts. Problems such as famines or resistance to colonial policies were often reported after the fact, by the next commander. In other cases, problems were overemphasized with the objective of getting more funds or personnel for the region. Still, such colonial documents form the only written material until independence in 1960 and are thus an important source of information, in addition to village and life history interviews. Especially when the reports from the regional authorities are combined with the letters of the supervising authorities in Ouagadougou or Niamey and with the reports of the regular inspection missions, a workable picture can be constructed of the developments in the region during the colonial period (see chapter 4 and Zuurd 1996; Lutgendorff 1997).

3.3.3 Development intervention studies

As a follow-up to the archival research of colonial documents, two students were asked to study the history of development interventions in the region after independence. One student focussed on the historical developments by studying annual reports and other written material from the intervening governmental and non-governmental organizations, in conjunction with some interviews with experts from these organizations (Boele 1998). The second student focussed on current practices, as found in the field, by visiting a number of projects throughout the region and interviewing local field staff of the same organizations studied by the first student (Gaanderse 1998). Both of these studies provided important information on post-colonial development interventions in the region and the difference between written intentions and actual practices in the field.

3.4 Village level studies

The village level studies were conducted as part of the village case studies and consisted of both quantitative and qualitative work. All methods that were primarily geared to describing and analyzing phenomena at the village level are discussed here, while those methods that focussed on the embedded cases studies of individuals are discussed in section 3.5. The activities discussed below were all carried out within the research villages with the exception of the market surveys, which were carried out at nearby markets. The reason that they are covered here is that these surveys focussed on understanding the economic environment of each of the research villages, rather than on providing some kind of representative data on markets for the research area as a whole (in that case the markets would have been selected based on other criteria than proximity to the research villages).

3.4.1 Participatory research

Participatory methods were primarily used during the exploratory fieldwork phase. These methods, as was explained in chapter 1, formed a corner stone of our approach, not so much because they served as primary data collection tools, but because they helped in establishing a relationship of mutual trust between the villagers and the researchers and their assistants. Such a relationship was fundamental to get at the local perceptions about soil and water conservation and to collect more sensitive types of information. This is not to say that the participatory methods did not serve as data collection tools in their own right. They were used for exploratory data collection and as such helped determine the criteria for the selection of case study individuals and helped design appropriate questionnaires for the survey work. The participatory methods will only be dealt with cursorily below, as extensive descriptions of the methods are already given in Mazzucato and Niemeijer (1996a, 1996b, 1996c).

Fieldwork in the main and secondary research villages was initiated with the village picture book method described in chapter 1 (but see also Mazzucato and Niemeijer 1996b, 1996c). Other methods employed included participatory mapping of the village territory, wealth ranking, genealogies, and eliciting and sorting of soil and crop names and characteristics (see Mazzucato and Niemeijer 1996a). Eliciting of soil and crop names was based on the free listing technique, while pile sorts and triad tests were done, with index cards stating the local soil names, to get insight in the soil characteristics and the taxonomic ordering of the different soil types (for details on these methods see Furbee 1989; Bernard 1994).

With the exception of wealth ranking, which was done with one or two respondents at a time, the other methods were done with different groups of people (men and women) in different wards, with the idea of getting acquainted with as many people as possible during this research phase. The participatory mapping was useful to get to know the village territory and learn the names of major water courses, paths and hills. The wealth rankings helped in the selection of households from which case study individuals were drawn and gave insight in local concepts about wealth. The genealogies provided information on the relationships within and between families as well as on the spatial distribution of these relationships. The soil names were useful for the agricultural study (discussed in section 3.5.3), while the discussion of their characteristics helped in understanding the local concepts concerning soils and their uses (chapter 6). Finally the crop and landrace (sometimes erroneously referred to as variety) names were used for several of the surveys discussed below, while the information that was collected on the origin of the landraces provided insight into processes of technological change (chapter 8). Many of these methods also helped us in establishing what further questions needed to be asked and how to phrase them.

3.4.2 Surveys

A number of surveys were carried out within the research villages and in some of the local markets. The main objective of the village level surveys was to collect quantitative information on the village population as a whole (i.e., all ethnic groups) to complement both the village level qualitative work (section 3.4.3) and the qualitative and quantitative information gathered as part of the case studies (section 3.5). The village level surveys had a dual purpose in that (1) they were used to quantify for the whole village population certain aspects that were found to be important in the qualitative or case study work and that (2) they were used to characterize the main research villages in terms of total population, household size, religious composition, etc. (chapter 4). The market surveys were used to collect information on: (1) market prices for agricultural, livestock, and other products; (2) price differentials within and between markets; (3) price seasonality; (4) frequency of market visits by sellers and buyers; (5) daily quantities sold and bought by individual buyers and sellers; and (6) the spatial range of markets.

The surveys were carried out by the research assistants after the questionnaires had been tested and the assistants trained. In all cases data-entry took place in Burkina Faso and was carried out by one of the research assistants. For the first survey this was done with a simple spreadsheet, but data-entry for all later surveys was done using a computer program specifically designed for data-entry of large complex questionnaires.[21] Data-entry was carried out parallel to the data collection work and as such also formed a check on the completeness of the filled-out questionnaires that were received from the field. To assure the quality of data-entry, prints of the entered data were verified with the data on the original questionnaires.

The village census and survey

Between July and October 1995, an exploratory village census was carried out in the two main research villages as well as in the southern secondary research village. In the northern secondary research village it was not carried out due to the village dispute mentioned earlier (section 3.1.1). The purpose of this survey was to determine the size and structure of the different wards and compounds and help with the selection of case study individuals.

Information was collected on the village organization in terms of the layout of the wards and compounds. For each hut in each compound, some basic information was collected on the married (including divorced or widowed) inhabitants such as the age, the

[21] Forms, developed for the Apple Macintosh at the African Studies Centre in Leiden (Netherlands). This program allows the user to create forms on the computer as they appear on paper and is therefore ideal for data-entry by people with no previous computer experience.

place of birth, the sex, the name of the father and mother, the relation with the compound head, the name of the wife or husband and the number of children.

Between April and May 1996 the exploratory village census had a follow-up in the two main research villages in the form of a more extensive population census. Through participatory work a number of issues had come up that we wanted to quantify such as the number of people living in bush compounds during the rainy season, the religious composition of the village and the landraces grown by different households.

The questionnaire for the population census was an adapted version of the "enquête permanente agricole" questionnaire of the Ministry of Agriculture (MARA 1994b). Information on all the married (or divorced/widowed) adults was collected per compound. This included: name, household, relation to the household head, ethnic group, age, sex, field ownership, whether the person was agriculturally active, languages spoken, religions practiced and the number of unmarried children in three age classes. In addition, some information was collected per household such as the total number of unmarried children in the household, information on bush compounds, and the location of the fields and main crops and landraces cultivated by the household head and his (first) wife.[22]

Parallel to the population census, a village survey took place. This village survey was conducted with a random selection of households, plus all households of compounds that had case study individuals. For Samboanli 29 households were randomly selected out of a total of 65 households leading to a coverage of 45%.[23] For Pentouangou 24 households were randomly selected out of a total of 85 leading to a 28% coverage. The village survey included additional information on household structure, migration and a number of other relevant aspects. In addition to married individuals, it also included unmarried household members. Information was also collected on migrations longer than one month that had been undertaken by household members. For each migration the destination, the type of migration, the duration of the migration, the year of departure and the reasons for the migration were recorded. Information was also collected on labor parties held by household members during the previous year. Per labor party, information was gathered on the month in which it took place, the activity concerned, the duration, the crops involved, the type and location of the field concerned, and the sex and place of residence of those invited.

The market surveys

Three different market surveys were carried out, each focussing on different aspects of markets and market prices. An exploratory market survey focussed on prices of products and on information about buyers and sellers frequenting the market. A general market survey concentrated on collecting price information for a fixed list of products. Finally, a price allocation study was carried out that looked into the role of the relationship between buyer and seller in determining the prices paid for products.

[22] This information was collected only for the household head and his (first) wife because this was considered indicative for where a household cultivated and the crops and landraces used by the household, while it reduced the amount of data that had to be collected.

[23] For Samboanli five Fulbe households living in a separate ward at some distance from the village were excluded from the village survey (but included in the population census), because they were suspicious of our activities.

The exploratory market survey took place between July and December 1995 and collected information on buyers and sellers in four local markets: Kikideni and Natiaboani near the southern research villages and Bilanga and Bilanga Yanga near the northern research villages (see map 3). During regular visits to these markets, which all have a three-day frequency, 10 randomly selected male and female buyers and 10 randomly selected male and female sellers were interviewed anonymously about the frequency with which they visited these markets, what other markets they visited and where they lived. The vendors were further asked for up to 20 products what the price was, in what unit, how much they sold of this product per day and whether it was their own produce and if not, where it was bought and from whom. The buyers were further asked for up to 20 products how much they bought of a product, in what units and for which price per unit.

The exploratory market survey was followed-up by a longitudinal general market survey that was conducted between March 1996 and February 1998. In order to better follow price fluctuations over time and to better compare prices between markets, the general market survey consisted of a more structured questionnaire to record prices for a predetermined list of products. Because the same product may be sold in different units, the most commonly sold unit was chosen. For most products this was the Yoruba plate,[24] but in some cases it was necessary to resort to less standard units such as a spoonful, a small plastic bag, a ball, or simply count the number of objects (e.g., mangos or onions) sold for a given price. On each market visit and for each product, prices of four different sellers were collected to get an impression of the price variations within the market.

The market survey was carried out in four markets: the daily market in Fada N'Gourma and the three-day markets in Kikideni, Bilanga and Bilanga Yanga. An assistant was appointed to the Fada N'Gourma market to collect data on a weekly basis for the whole two year period. The other markets were covered by our research assistants on a bi-weekly basis during the first year of the survey. In the second year the Kikideni market was eliminated from the sample because it tended to be so small that most products were simply not sold, especially during the rainy season. For the Bilanga and Bilanga Yanga markets local assistants were appointed to cover the markets every six days starting in April 1997.

Prices were collected for the following product categories: grains, vegetables and fruit, prepared foods, milk products, seasonings, bush products, livestock, local ropes, and miscellaneous food products. Local textiles and industrial products were not covered. Except for poultry, livestock was only sold on the Bilanga Yanga market and at the weekly Sunday livestock market in Fada N'Gourma. For the latter market, an additional questionnaire was used to collect data on fodder and local ropes. Fodder prices were collected for up to 13 sellers for various crop residues as well as 10 local grasses and herbs. In each case the price and weight per bundle was determined as well as the quantity the seller had brought to the market. Prices and weights per bundle for the local ropes were collected for up to three sellers.

A price allocation study was carried out between May 1996 and August 1997. For this study a randomly selected seller was observed at random times of the day for a length of

[24] For a number of products the average weight of a filled Yoruba plate was measured to be able to calculate prices per kilogram.

time ranging between half an hour to two hours. During this period every transaction of a certain product type was recorded in terms of the price of the product declared by the vendor, the quantity bought, the price paid by the buyer, the discount given, if any, and the relationship between the buyer and seller. In total 37 visits were made in which one to three sellers were recorded per visit resulting in questionnaires being filled out for 28 different product types in one year. This survey was conducted in Kikideni, Bilanga and Bilanga Yanga markets.

The technology survey

For the last phase of fieldwork, a technology survey was designed to quantify for the village population as a whole some of the aspects related to technologies and their use that had come up during the case study work. This survey had five objectives: (1) to find out what modern agricultural and transport technologies people owned and when they had first acquired them; (2) to determine how such investments were made in terms of the origin of the money used and the available reserves (livestock); (3) to quantify lending and borrowing of agricultural equipment; (4) to get some insight into current livestock ownership and when animals were first acquired; and, finally, (5) to quantify the use of soil and water conservation practices.

The questionnaire was concerned with the following agricultural and transport technologies: bicycles, motorbikes, plows, donkey carts, and draft animals. For the first four technologies, respondents were asked amongst others, when they had first acquired it, how many they had, what price they had paid, what money had been used, and how many cattle they owned at the time of acquisition. For the plows and donkey carts additional questions focused on where and how the equipment was acquired (e.g., bought, on credit, gift), whether they were still using the first plow/cart they had bought, and how often they lent or borrowed such equipment. Respondents were also asked for the type of plow they used, while for the donkey cart they were asked for what purposes they used it. For the draft animals questions were asked on the number and type of animals, when they were first obtained and how many times per year animals were borrowed or lent out.

Concerning livestock ownership the respondents were asked when they first obtained cattle, sheep and goats and how many they currently owned. As livestock ownership is a sensitive issue in this area, as elsewhere in Africa, the first question is likely to have been answered more openly than the latter. For cattle a further question was whether they were kept inside or outside the village and who was herding them (e.g., a child, a relative, a Fulbe).

The final section of the survey was concerned with soil and water conservation, inquiring about a wide range of mechanical and agronomic/biological practices, whether the respondent applied them and, if so, on which kind of fields and for what crops.

This survey was to take place with the married men and women of the same households that had been included in the village survey. In practice a lot went wrong. The survey was to be carried out between April and June 1997. Because this was during our absence from the field, it took too long before we found out that it was going too slowly to be terminated in time for the rainy season when farmers would be occupied. To make things worse, it turned out that the least relevant people had been interviewed first, which led to an overrepresentation of women and Fulbe, while most of the questions were particularly relevant for Gourmantché men. After the harvest, in January and February 1998 a few more people were interviewed, but not enough to complete the survey. As a result the survey no longer represents a random selection of individuals and can thus only be used as a general indication of certain trends.

3.4.3 Qualitative research

Qualitative research helped in designing locally relevant questionnaires, but more importantly, provided the kind of insights that are hard to get through quantitative research methods. Most of the qualitative methods that were used have their origin in the social sciences, most notably anthropology.

Qualitative research was carried out both outside and inside the village. The activities that took place outside the village concerned historical work at the regional level, some interviews on local markets and two studies on development interventions carried out by students. Inside the village a distinction can be made between qualitative work carried out as part of the embedded case studies of individuals and the work done in the context of the village case studies. Methods that were employed for the embedded case studies are discussed in section 3.5, while methods used for the village case studies are presented here.

Semi-structured interviews and conversations

Throughout fieldwork heavy use was made of interviews and conversations. The main difference between these methods was that the interviews were semi-structured and generally focused on a particular topic, while the conversations were informal and could be on any topic that was raised by the researcher or informant.[25] In all cases the interviews and conversations were assisted by a research assistant who would do the interpretation between French and Gourmantchema. This was also the case for the social anthropology student who did research in one of the secondary research villages to generate material for comparison (Wolffenbuttel 1997).

Conversations were often related to observations made while, for example, walking with a farmer through the fields or, while observing food preparation. In yet other cases they consisted of discussions at night in the chief's compound. The conversations assured that not only information was gathered on pre-determined topics, but that issues not thought of beforehand could also arise (Bernard 1994: 209). Such issues could then at a later time become the topic of an interview.

The interviews were semi-structured with some questions prepared beforehand and others coming up during the interview. Interviews were generally taped and afterwards transcribed in French by an assistant. A few assistants were specifically trained for this task to make sure that an accurate and detailed transcription was obtained and that relevant words and expression would be quoted in Gourmantchema. In most cases we conducted the

[25] Conversations are sometimes also referred to as informal interviews (Bernard 1994: 209).

interviews ourselves, but in some cases one of the field assistants was asked to do an interview with someone on a particular subject. Most interviews were done with single individuals, both men and women (depending on the topic). A few group interviews were also held, for instance on the agricultural calendar and the activities required to cultivate a field.

Oral village and life histories

Oral history interviews were used to collect historical information on the village and the changing livelihood patterns in the region. In the oral historical interviews a person or sometimes a group of people were interviewed on a specific topic such as the village history or how the livelihood of the villagers had changed over the years. The problem with such interviews, however, is that because the topic is discussed in a general sense, the interview becomes impersonal, making it much more difficult to elicit memories than during the personal life history interviews. Thus, whenever the topic allowed, life history interviews were conducted instead of general oral historical interviews, to get at the social and agricultural changes undergone in the research area over the twentieth century. In most cases the interviews were held with the oldest villagers (men and women). For our case study work, however, we also did life history interviews with the same men and women with whom we did an agricultural study (section 3.5.3).

Some interviews were held outside the research villages, at one of the local markets or in Fada N'Gourma. At the local markets interviews were held with individuals who were not only very old, but also known to be knowledgeable on the history and development of the market. In Fada N'Gourma some interviews were held with very old men who had a reputation for knowing the history of the research area. In addition, some retired government workers were interviewed who, through their work for the colonial administration or the extension service, had particular knowledge on the agricultural developments in the region.

Oral sources clearly have their limitations in that they do not lend themselves to the collection of all types of information (e.g., exact dates or the order of events), depend on the memory of the informant, and are subjective. They do, however, offer insights that are hard to get otherwise by allowing the documentation of the lives, feelings, and experiences of all kinds of people, not just those that produce written testimonies of their opinions or experiences (Thompson 1988). Especially in the West African context, where there are few historical documents available and those that are available represent the perspective of the colonial power, oral sources can be very valuable.

Observation

Though simple as it may seem, observation has been one of the most important research methods that we employed. Observations formed a major source of material to discuss during interviews and conversations, or to attempt to quantify through surveys. Observations also helped to go much deeper into topics because they regularly countered what had been said at first instance in an interview or during a conversation. Observations thus helped us to stay away from the development discourse and forced informants to avoid easy answers to our questions.

A great deal of time was spent on walking (or in some cases bicycling) through the village territory, around fields at various stages of the growth cycle and in some cases assist with the harvesting of a crop, the threshing of sorghum heads, pealing groundnuts, pulling leaves from their stem, etc. We, in other words, practiced a form of participant observation.[26] Many interviews and most conversations did not take place under a tree in the village, but in the middle of the fields or on the top of a local hill. Observations thus provided immediate feedback on what was said and facilitated comparisons between fields and the practices of different farmers. They also helped gain insight into matters not so openly discussed such as gift giving, livestock ownership, and Gourmantché-Fulbe relations.

Assistant reports

For the almost three years that fieldwork was carried out, the researchers were present in the field for a little less than half of the time. In other words, often field assistants worked independently and were the only ones there to make observations, get into casual conversations, and overhear what villagers were saying. For that reason they were asked to write weekly reports about observations and conversations pertinent for this study. With time and training these reports got better and provided very useful information that we could follow-up on during our own fieldwork.

Research on the Fulbe

Though the prime focus of this study is on the Gourmantché ethnic group, the Fulbe not only form an important minority of the village population, but also, as livestock herders, play an important role in the livelihood strategies of the Gourmantché. While we have tried to maintain contact with both groups throughout our fieldwork, because of time constraints we had to focus on a single ethnic group. In addition, the relationship between the Gourmantché and Fulbe is sometimes problematic (chapter 8), thus establishing a relationship of trust with both groups at the same time would not only have been extremely time consuming, but very difficult. Instead, a young university trained Fulbe sociologist was asked to work for one year with the Fulbe population in both of the main research villages. He kept a diary which was reviewed monthly by the researchers and formed the basis for guiding his further research. Alternating weeks in the two villages, the assistant gained the confidence of some of the Fulbe and provided many insights on "the other side of the story" (see Diallo 1997).

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[26] There are various interpretations as to what should be considered participant observation. Bernard (1994: 137-138), for instance, distinguishes between plain observation where the researcher just observes, the role of participating observer, where the researcher participates in the lives of the respondents as an outsider, and the observing participant that joins the ranks of the respondents and observes as an insider. In Bernard's view both latter ones may be considered as participant observation. Yin (1994: 86-89), however, seems to consider only the latter case as real participant observation.

3.4.4 Changing land use study

Through a temporal analysis of aerial photographs and group interviews, the land use changes that took place during the second half of the twentieth century were documented. On this basis, assessments are made, in chapters 5 and 6, of the impact of population growth and agricultural expansion on the vegetation and the spatial dimension of land use.

This study was largely carried out by a student under supervision of the researchers (for details see Bannier 1997). In The Netherlands, aerial photo interpretations were made for the photos listed in table 3.2. For the 1955/56 series, land use and vegetation were mapped. Artifacts (e.g., roads, paths, buildings), drainage and geomorphology were additionally mapped for the most recent photos (1988 for Pentouangou and 1994 for Samboanli). Based on the drainage and artifacts interpretations, a preliminary field map was made that was taken to the main research villages. Villagers were asked during a group meeting to help identify landmarks such as hills and watercourses on enlarged aerial photographs and provide names for these landmarks that could be added to the preliminary map. They were also asked to indicate the borders of the village territory and the different farming zones. Through an iterative process using the enlarged aerial photographs, the preliminary map, and drawing with sticks on the ground, we were able to label most of the landmarks and farming zones.

The next step was to locate river forks, road-river crossings, etc. that were indicated on the preliminary map in the field and use those points for geo-referencing and rectification of the aerial photographs. Using the local names on the preliminary map, one of the villagers was asked to accompany the student to each of the sites. Coordinates were determined through differential GPS to achieve a horizontal accuracy of 1 to 5 meters. Given the scale of the aerial photographs and the difficult terrain, it was not always easy to locate the right sites, also as there was sometimes confusion over the proper local name for a watercourse or farming area.

Parallel to geo-referencing, ground-truthing of the photo-interpretations took place by recording land use at a number of random sites in the various farming zones and by studying a transect in each of the main research villages. For these transects land use, local soil names, and vegetation were recorded at regular intervals. A problem with ground-truthing, however, was that while fieldwork was done in 1997 the aerial photos dated from 1994 or earlier, which made ground truthing of field and recent fallow areas very difficult.

After the terrain work, the preliminary village map was updated in another group session to incorporate field observations and make corrections where confusion had arisen

Table 3.2 Aerial photographs used to map land use changes

	Pentouangou		Samboanli	
	Old series	Recent series	Old series	Recent series
Date	2 March 1956	March 1987	29 November 1955	16 December 1994
Series	NC-31-XIX	88091-B Gourma	ND-30-VI	94137-B Gnagna
Photo numbers	403, 404, 438, 439	7758, 7791	232, 233	1829, 1855
Scale	1:50,000	1:50,000	1:50,000	1:50,000

Sources: Institut Géographique du Burkina (Burkina Faso) and Institut Géographique National (France).

over proper naming of land marks or borders of farming zones. Finally, this map was used in another group session to draw an exploratory local soil map.

Structured interviews were carried out to supplement the maps with information about each of the farming zones regarding cultivation intensity, changes in vegetation and land use, information on soil types, soil fertility and processes of land degradation. In Pentouangou these interviews took place for 20 of the 22 farming zones (covering most of the village territory). In Samboanli they took place for 7 of the 14 farming zones, covering some 75% of the village territory.

3.5 The case studies of individuals

Towards the end of the exploratory research phase, a total of 35 individuals were selected in the two main research villages as case studies nested within the village case studies. This work was conducted during two agricultural seasons. Through these case studies we wanted to get more insight into the interrelation between land use practices and livelihood strategies. As was explained in chapter 1, the case study method is ideal for answering questions on why people use certain soil and water conservation practices and how agricultural decisions are related to, for instance, economic and social considerations.

The section begins with a discussion on the selection of the case studies and the multiple units of analysis that were used. This is followed by an in-depth discussion on the different qualitative and quantitative research methods that were employed to study the livelihood strategies and the physical land use practices of case study individuals.

3.5.1 Selection of the case studies

The household, often defined as the group of people, related or not, that recognizes the authority of the same single person, lives together, often eats together, and together contribute to the daily costs of living (Vaugelade 1991), is the unit that is most typically analyzed in African societies by economists (Guyer 1981). However as Guyer (1981) points out, the use of such a unit implies a whole range of issues regarding how domestic units function and their access to the kinds of resources that are at stake in present day Africa. Analyzing decisions at the household level implies that a household controls resources together and makes joint decisions as to how to allocate them. However, as many studies especially from anthropologists have highlighted, these assumptions are not correct in the African context. For example, the high mobility of individuals, high divorce rates, and the extensive fostering of children make the household boundaries dividing who is considered part of the household from who is outside the household, very fluid (see for example Etienne 1979). Furthermore, different trends affecting the position of young or female members within a household have led to conclusions such as Hill's (1975) that in West Africa husbands and wives seldom form a unified production unit, or that the control of a man over his juniors has become increasingly limited (Wallace 1978). For these reasons Guyer (1981: 99) concludes that using the household as the major analytical unit, hides three critical factors all of which are interconnected and have important consequences for decision making: a) the relationship between men and women, b) the relationship between older and younger men, and c) the relationships between domestic groups where wealth and control over resources vary widely. Based on these considerations, the individual was chosen as the unit of analysis for case study research in this study in order to understand the possible effects of the earlier mentioned dynamics in African societies on the system of agricultural production.

At the same time though, an individual does not act independently of his or her relationships with other people. There is much complementarity and mutual dependence between the individuals within a household (e.g., Hill 1975) as well as within a compound.[27] We therefore selected all case study individuals from five households in each of the main research villages. Furthermore, these five households were selected from three rather than five different compounds. This setup allowed us to study the relationships between individuals and other members of their household and compound. Finally, since the early studies on lineage groups, anthropological literature has highlighted the importance of kinship ties in defining people's access to and control over resources. Thus while the case study unit in this study is the individual, most of the research methods described below (budget diaries, stock study, cultivation histories, and agricultural questionnaire), either integrally, or partially, focus on questions regarding the relationships between the individuals and the people with whom they transact.

Given our focus on relationships and that the first level of relationships are within the household, we selected case study individuals based on household characteristics. The households were selected based on the wealth rankings, the exploratory village census, our observations during the first five months of fieldwork, and the observations of the research assistants. The following criteria were applied per village: (1) at least one poor, one average and one well-to-do household; (2) at least one farmer known to be very good; (3) at least one small and one large household; (4) at least one young and one old household; (5) at least one monogamous and one polygamous household; (6) the households should come from at least two village wards; and most importantly (7) the likelihood that the members of the household would be willing to cooperate with us. In addition, we wanted to include households from the chief's compound for correctness in the eyes of the villagers and to stimulate collaboration of the other villagers. In both villages there were two compounds in which two households were selected and one compound in which one household was selected because the compound had only a single household living there.

Table 3.3 shows the composition of the households that formed the basis for the case studies. As can be seen from the table the households in the northern village tend to be larger. This is in agreement with the larger average household size found in this village (chapter 4). It may also be noticed that all categories of people are well represented in both villages except the category brother of household head, which does not occur in the northern village, but occurs twice in the southern village. This is a coincidence and not related to any fundamental difference between the villages. Another difference between the households is that in the northern village they are at a slightly further stage in the family life cycle as is evidenced by the higher percentage of children over eight years of age.

[27] The compound is defined as the principal unit of residency.

Table 3.3 Case study individuals and composition of their households in 1996

Household	Male head of household	Brother of head	Wives of head/brother	Elderly father	Elderly mother	Children		Total
						< 8 years	> 8 years	
			Samboanli (northern village)					
S1A	1		1	(1)[a]	1	(3)	(5)	3 (+9)
S2B	1		1 (+5)			(3)	(15)	2 (+23)
S2C	1		3			(4)	(6)	4 (+10)
S3D	1		1		(1)	(2)	(2)	2 (+5)
S3E	1		2		1	(6)	(6)	4 (+12)
Total	*5*	*0*	*8 (+5)*	*(1)*	*2 (+1)*	*(18)*	*(34)*	*15 (+59)*
			Pentouangou (southern village)					
P1A	1	1	2	1	1	(5)	(1)	6 (+6)
P1B	1		2			(3)	(4)	3 (+7)
P2C	1		1	1	1	(1)	(3)	4 (+4)
P2D	1		1			(3)	(2)	2 (+5)
P3E	1	1	3			(3)		5 (+3)
Total	*5*	*2*	*9*	*2*	*2*	*(15)*	*(10)*	*20 (+25)*

Source: 1996 village population census.
Note: The number of households members not selected for a case study are indicated per category between brackets.
[a]Died in the course of this study.

The case study individuals consisted of all the adults of the households listed in table 3.3, with two exceptions: for the household S3D the elderly mother was not included and for the household S2B, where the household head has six wives, only the third wife was selected to keep the work manageable. This way 6 men and 10 women were initially selected in Samboanli and 9 men and 11 women in Pentouangou. Because the elderly father in household S1A (Samboanli) passed away in the course of the study, the total number of case study individuals became 35. Broadly speaking two type of activities were undertaken with the case study individuals: a livelihood study and an agricultural study, each consisting of a number of separate activities discussed below.

3.5.2 The livelihood study

To collect information on the livelihood of the case study individuals, budget dairies were recorded and a stock study was done. In addition, for a few case study individuals, a time allocation study was conducted.

The budget diaries

The way people allocate their resources makes visible statements about the hierarchy of values guiding what "makes sense" in that society (Douglas and Isherwood 1996). We studied how people chose to allocate their material and at times non-material resources by keeping budget diaries for all of the case study individuals with the reasoning that through an understanding of these transactions, insights could be gained into the concepts that guide the local economy.

Budget diaries were recorded for all of the case study individuals (see section 3.5.1 for details) from April 1996 to February 1998. This resulted in 11 women and 9 men in Pentouangou and 10 women and 5 men in Samboanli participating in this study. The budget diaries record any time that a case study individual engaged in a transaction, that is, whenever a good, service or money exchanged hands going from or coming to the case study individual. The type of transactions recorded are buying, selling, gift given, gift received, exchange of one thing for another, salary received, salary given, migration remittance received, taking out a loan, paying back a loan, giving out a loan, having a loan reimbursed to them, contributions to or from a credit association, and other. For each type of transaction the date, object, quantity, value in fcfa (if known), the relationship and ethnicity of the person with whom the transaction was carried out, and where it was conducted. This study comprised our largest data set with well over 3,000 transactions in each of the two villages and each transaction with 18 analyzable characteristics.

As virtually all individuals are illiterate, the budget diaries were recorded by our research assistants once every two weeks. Recall over a 14 day period is difficult for activities such as transactions that happen with great frequency, therefore we asked the individuals to recall the information for the preceding three days. Additionally, they were asked to recall any "exceptional" transactions occurring within the 14 day period, for example, the purchase of a cow. This method of data collection resulted in having data for "regular" transactions for only three out of 14 days but of greater accuracy. It also meant that during data analysis values of the regular transactions for the remaining 11 days needed to be interpolated.

Before interpolation could be done, seasonality of spending patterns needed to be taken into consideration. This was done by dividing the transactions into four months periods: December – March, April – July, and August – November. December was chosen as the starting point of the first period because, although harvesting has already begun, it is when the bulk of harvesting work is completed, people who were temporarily living in a bush camp came back to the village, people begin to have time to transact, social life picks up once again, and many festivities are held during this first period. All of these factors lead to there being a great number of transactions during this period. In the second period, agricultural work picks up again, time to transact becomes less, and, for the studied years, people still had stocks of their grain production that they could consume. In the final period, some people's stocks were finished but the new harvest was not yet in. This is a difficult period for some and is when certain types of transactions catering to people's basic needs occur.

Another aspect that needed to be dealt with before interpolation could take place, was to determine which transactions were regular and which exceptional. This is because exceptional transactions would need to be kept at their recorded value while regular transactions would need to be interpolated for the 11 day period between two visits. Transactions reported outside of the three-day recording period were by definition exceptional. Within the three-day recording period instead, transactions were grouped by type of transaction, what was transacted and the respondent's sex. For each of these different groups a frequency distribution was calculated and all values falling below the 75th percentile were taken to be regular and the rest irregular.

At this point, regular transactions could be interpolated. Regular transactions for each person were summed, divided by the amount of days recorded in that period for that person, and then multiplied by the number of calendar days in that period. The interpolation can be summarized by the formula below. In this way we got values of transactions for all days of the year.

$$\text{value for period} = \left(\frac{\text{recorded value}}{\text{number of days recorded}}\right) \times \text{number of days in period}$$

Additionally, in September – October 1996 semi-structured interviews were conducted with each of the respondents about their budget diaries. These interviews served various purposes. They revealed the sensitive nature of certain very important types of transactions, such as the purchases of cattle or women's gift giving to their paternal families. The goals of the interviews were thus to assure the respondent of the anonymity of the information that he or she gave, and to further establish a rapport of trust with the villagers participating in this study. Furthermore, they helped in making the assistants more apt at asking questions in a sensitive and perceptive way so that they could get information which may not have come out upon first questioning. In fact, after these interviews, the accuracy of the data greatly improved.

Given the greater accuracy of the data after October 1996 and that field and plot level data for these respondents was collected for the 1996 agricultural season, it was deemed most accurate and most interesting to analyze the data for the budget year starting in December 1996. This meant that the first eight months of less accurate budget data were not utilized and that the budget analysis coincided with the field and plot level analyses allowing us to associate what happened in fields to how people transacted.

Finally, budget data related to own production was checked with data collected in the stock study described below. The stock study at times provided greater detail about transactions conducted with one's own production given the nature of the questions asked and therefore supplemented data from the budget diaries.

The stock study

We collected three years of agricultural production stock data because we were interested in knowing how much people produced, how they used their production, and how they accessed food in case their production was not enough. This information was collected through three rounds of a stock survey. The same individuals participated as those of the budget diaries. In the first round, data were collected about the 1995 harvest late in 1996. This means that people were asked to recall their previous harvest over a period of 10 to 11 months. This activity was initiated despite the long recall period because it resulted from some of our interviews and work on the budgets that most case study individuals were well aware of how much they harvested and were able to express the quantities in basketfuls. In this first questionnaire each person was asked for each crop that they cultivated, how they stocked it, what landraces they had, how much they had stocked after the harvest, where the stock was located, whether there was some leftover in the stock from the previous harvest, if yes, how much, in what form the crop was stocked (grain, in shell, etc.), and if there was still something left of this year's stock. Additionally, the respondents were asked to explain how the stock had been used by indicating every time that they took something out of the stock: when they used it, how much, and for what purpose. These last data however, were not very detailed in the first round given the long-term recall requested of respondents.

A second round was conducted for the 1996 agricultural season in which the questionnaire was slightly modified to include the respondent's estimate of the conversion rate between the local units used by the respondent such as basketfuls or large and small plates and Yoruba plates. At times respondents gave their answers in more standard measures such as old and new sacs of 50 kg and 100 kg and for a standard local tin measure called *tine*. For these units, the Yoruba plate equivalencies were gotten from a small market survey in which vendors in various markets were asked for the Yoruba plate equivalencies of the different units for different kinds of crops. As these estimates were fairly uniform throughout markets and vendors, we judged them accurate conversion rates. Additionally, the Yoruba plate of each crop was weighed in order to convert all units into kilograms.

In this round, questions regarding the content of the stock were asked just after the harvest and questions regarding the use of the stock were asked on a regular basis throughout the year so that recall periods were much shorter than in the first round. Not surprisingly, data for this round are much more detailed. This round also included questions about buying of crops. Each respondent was asked if they bought additional quantities of a crop in order to supplement their own production and if so, when, how much, for what use, and the price at which they bought and/or resold the crop.

A third and final round was conducted for the 1997 agricultural season. The same questions were asked in this round but because our fieldwork ended shortly after the harvest of this agricultural season, the objective of this round was to get an idea of the quantities people harvested and how they used their stocks in the period just following the harvest. This information was used as comparison with the previous year's data.

The stock survey provided the most accurate estimations of total harvests per crop compared with two other methods we tried: crop cuttings and farmers' estimates of plot production (Niemeijer *et al.* 1999). It also provided interesting information about losses due to animals eating the crops and how the resulting disputes were settled. Because of the nature of the questionnaire which focussed all questioning on one's own production, it seemed also to produce more accurate figures on transactions regarding own production. This not only includes selling and consuming one's production but also the gifts that were given with one's own production and on what occasion. This information helped triangulate with budget data and formed a basis for further topic interviews with respondents.

The time allocation study

Time allocation studies were conducted to gain insight into the amount of time individuals dedicate to different tasks. Usually such studies are based on spot sampling whereby individuals are observed at randomly selected places, and randomly selected times, to record what they are doing at that particular moment (Bernard 1994). There are at least three problems with this approach: (1) the behavior of the person may be altered by the approach of the researcher before the observation can be made; (2) it is impossible to place spot observations within the context of the other activities that take place before and after the observation is made; and (3) a very large sample of observations is required to include also the shorter duration activities. We therefore opted for a so-called continuous monitoring approach (Bernard 1994) whereby a single individual is monitored for a full day from waking up until going to bed. During monitoring the duration of every activity is recorded together with a description of the activity and its context. This approach lends itself less well to statistical generalization than spot sampling, but allows the context of the activity to be taken into consideration and does not underestimate short duration activities. The influence of the observer on the observed remains a problem that will, however, become less as the observed person gets used to the presence of the observer.

Between July and October 1995 an exploratory time allocation study was done that covered most of the rainy season. For this study a randomly selected individual was followed for a whole day by a research assistant. Information per activity was recorded relating to how long it lasted, what it consisted of, how many other people participated, what tools and materials were used. Individuals were selected from both the Gourmantché and Fulbe population. Men were followed by the male assistant and women by the female assistant. The activity was restricted to the two main research villages because of its time consuming nature. For each village some 20 individuals were monitored.

Between May 1996 and January 1997 a second, more structured time allocation study was carried out with some case study individuals. Based on the experiences with the exploratory time allocation study a questionnaire was designed that covered the most important activities. For each activity the type of activity, the location and the duration were recorded. About 15 time allocation questionnaires were filled out in each village during the course of the study.

3.5.3 The agricultural study

For a sub-selection of case individuals an agricultural study was done that focused on understanding land use practices from both a social and a technical perspective. This sub-selection consisted of the adults of three of the five selected households, while for the measurement of field size and the estimation of agricultural production also the children of those households were included. For Samboanli the selected households were S1A, S2C, and S3E giving a total of 11 adults and 30 children. For Pentouangou these were P1A, P2C, and P3E with a total of 15 adults and 13 children. To get insight in the medium to long-term agricultural decision-making a cultivation history interview was held with each of the individuals covering the different fields the person had cultivated in the past, the agricultural technologies that were used, the reason for abandoning the successive fields, and so forth. To gain insight in the short-term decisions all the fields cultivated by the case study individuals in 1996 and 1997 were studied from both a social and a technical perspective. As most fields consist of multiple plots with different cultivation histories and different crops this work was mainly carried out at a plot level.

As can be seen in table 3.4 a total of 73 fields, constituting 122 plots were cultivated by the selected case study individuals and their children during the 1996 growing season. For all plots, except the twenty-two plots cultivated by children, a questionnaire was filled out and interviews were done on issues such as land tenure, soil types, landraces grown, crop development, and labor input. For the majority of plots (including those of children) the area was measured and the production was estimated by the farmer. In a few cases area measurements did not take place due to time constraints. More frequently farmer estimates of production were not available because the farmer no longer remembered how much had been harvested from a specific plot. This mostly concerned small plots with minor crops such as soya, rosella, and okra. For a sub-selection of plots, yields were measured and soil samples were collected, as our team was too small to cover all plots. Finally, daily rainfall was measured in each of the farming areas in which plots of case study individuals were located.

Cultivation history interviews

The cultivation history interviews took place as part of the agricultural study. They consisted of semi-structured interviews using a topic list. The interviews focussed on the period between the first time an individual started cultivating (usually on the father's or uncle's field) up to the present. The interviewee was asked to recall all the different fields cultivated during her or his life time, where they had been located, what crops and landraces had been grown there, why they had been abandoned, etc. These land use related questions were often combined with questions related to the life history of the interviewee such as the family situation and the financial developments. In some cases all these issues were addressed during a single interview, in other cases an earlier cultivation history interview was followed-up with a life history interview or vice versa. In this way a wealth

Table 3.4 Overview of data collected on plots used by case study individuals and their children in 1996

Household	Number of fields	# of plots used by Adults	# of plots used by Children	Total # of plots	Number of plots for which Questionnaire completed	Area measured	Production estimated	Yield measured	Soil sampled
					Samboanli				
S1A	8	12	3	15	12	10	12	6	7
S2C	19	17	9	26	17	20	11	7	6
S3E	19	22	9	31	22	31	25	13	14
Subtotal	*46*	*51*	*21*	*72*	*51*	*61*	*48*	*26*	*27*
					Pentouangou				
P1A	10	15	0	15	15	15	12	9	8
P2C	8	8	1	9	8	7	8	3	4
P3E	9	26	0	26	26	23	17	6	12
Subtotal	*27*	*49*	*1*	*50*	*49*	*45*	*37*	*18*	*24*
Total	*73*	*100*	*22*	*122*	*100*	*106*	*85*	*44*	*51*

Source: Fieldwork.

of information was collected on both the individual life history and the changes the farming and livelihood system had gone through during the second half of this century.

The agricultural questionnaire

The agricultural questionnaire was an extended version of the questionnaire of the Ministry of Agriculture (MARA 1994b) used for the "enquête permanente agricole" and covered a wide range of issues from the physical characteristics of the plots to labor input and crop development. It was the central instrument of the agricultural study.

For each field of the case study individuals taking part in the agricultural study, information was collected on the type of tenure, the type of field, the topographical position of the field, how the field was obtained, and when it was fallowed in the past. A map was also drawn, indicating the shape of the field, the location of the different plots that made up the field, the location of soil and water conservation structures, etc. For each of the plots information was recorded on the crops and landraces grown and the way these had been planted (monocrop, intercrop, field border, etc.). Further, information per plot was collected on soil and water conservation structures, trees, local soils and soil cover at the onset of the season. In practice, the information collected on trees and soil cover has remained incomplete for lack of time. Finally, the size of each of the plots was measured following the procedures described in MARA (1994b).

Information on the development of the crops and the agricultural activities undertaken was collected on a per plot basis. This included manure and fertilizer applications, the timing of the cycle of the crops (this information was not complete for all plots), the people participating in the different cultivation activities, and the amount of man, woman and child-days spent on these activities and their timing. Information was also collected on eventual work parties, such as the origin and number of participants and the food and drink offered. Finally, after the harvest, information was collected on the total production of the plot through farmer estimates.

The agricultural questionnaire served both as a data collection instrument conducted by the research assistants and as a basis for follow-up interviews and observations by the researchers. In all cases this work took place at the field for which information was being collected.

Yield measurements

Yield measurements were conducted for three reasons: (1) as a way to calculate the production per plot; (2) to relate yields with soil types and soil fertility; and (3) to determine the yield level and yield range attained with the local cultivation practices. The yield measurements were part of the agricultural study and took place in both the 1996 and 1997 season on a selection of plots cultivated by case study individuals.

The procedure for the yield measurements was that on each plot two 5 by 5 meter sample squares (25 m^2 each) were laid out in which the number of hills and the number of plants were counted for each of the crops encountered within the sample square. The number of sample squares and their size were chosen as a compromise between accuracy and the amount of work involved. Because of high spatial variability in crop growth, a single sample area was deemed insufficient while more than two were considered too laborious and leading only to a slightly better estimate (Jan-Willem Nibbering and Jan Piet van der Mijl, personal communication).

Initially the sample areas were placed randomly following the procedures described in MARA (1994b), later we decided to have the sample areas correspond to the parts of the field where, according to the farmer, the best and poorest soils were found. This had several benefits. We would get a better picture of the yield variability within a plot, yield measurements and soil sampling (see below) could be better matched, and by asking farmers to indicate how the sample areas had performed compared with the rest of the field, the production estimate for the plot as a whole might even be better than an estimate produced by random measurement.

At harvest time the above-ground biomass was weighed, stalks separately from the heads. The heads were also counted. Some two weeks later heads were threshed and grains were weighed. Groundnuts were only weighed once, in shell. Small samples were taken of the stalks, the cereal grains and the groundnuts in shell. These samples were weighed at home in Fada N'Gourma and then air-dried and regularly weighed until the weight of the sample stabilized (usually between one and three weeks). On this basis the moisture content at harvest time of the stalks, grains and shells was determined per crop per sample area. For groundnuts the relative weight of shell and nut were also determined.

Yield measurements did not take place on all plots, because for some crops such measurement proved too problematic. The only crops that posed no such problems were sorghum, millet, groundnuts, Bambara groundnuts and sweet potatoes. With the other crops, various problems were encountered.

Yields for the vegetable crops (notably rosella and okra) were difficult to measure as these are often harvested bit by bit, as sauce ingredients are required and plants attain maturity. Because the plots of these crops tend to be small and, while important in the diet, they do not form major staples, lack of yield measurements for these crops were not a serious omission for our purposes.

Yield measurements for maize partly suffered from the same problem of bit-by-bit harvesting, but a more important problem was that this early maturing crop is a fundamental source of food at a time when one year's harvest is finished and the next harvest is not yet in. Thus if the assistants arrived even just one day after the harvest of the sample area the maize might already have been consumed.

A very different problem was encountered with the yield measurements for rice fields. During flooding the markers of some of the sample areas were lost mid-way into the season. When there was time again to re-position markers at the sample locations the rice had reached a development stage in which walking through the field to place markers would have caused crop losses due to easily disturbed rice panicles.

A final category of crops that posed problems were the low-density intercrops such as cowpeas (grown with millet and sorghum) and sesame (usually grown with groundnuts). The size of our sample areas did not give a sufficient representation given the low density of these intercrops, which led to either an overestimation or underestimation of the intercrop for that individual plot (usually the latter). An additional problem was that these crops are often harvested just before (or sometimes after) the primary crop creating two very different problems. Firstly, it meant that a second measurement round was necessary for each of the plots to measure the yield of the intercrop, which due to time constraints often posed problems. Secondly and more importantly, it meant that the farmer, and whoever else helped with the harvest, had to leave the sample area untouched at two occasions: during the intercrop and the primary crop harvest.

Soil sampling and soil profile description

Parallel to the yield measurements, topsoil samples were collected on agricultural plots and, in addition, on long-term fallows. Most of the sampling took place towards the end of the rainy season in September and October 1996 while some further samples were collected during that same period a year later. At a separate occasion, in April 1997, soil profile descriptions were made and horizon-wise sampling was done in both villages for the most important local soil types.

The purpose of topsoil sampling was threefold: (1) we wanted to find patterns in the soil fertility characteristics of the most important local soil types; (2) we wanted to compare the fertility status of cultivated and uncultivated sites; and (3) we wanted to link the results of soil chemical analyses with the yields and other information collected for the fields and plots of the case study individuals. As the soil sampling effort had multiple goals we did not opt for a strict random sampling procedure. Instead, a design was chosen that linked soil samples to the plots of the case study individuals, by sampling the soil inside the yield measurement squares. As soil spatial variability is known to be very high in the semi-arid zone (Brouwer and Bouma 1997), multiple samples per plot were collected. In fact, to catch the maximum variability with the minimum number of samples, two bulk samples (each consisting of a mixture of three to five sub-samples within a radius of a few meters) per plot were taken, based on what the farmer (or informant) indicated as the highest and lowest fertility site of the plot.[28] A further benefit of this sampling design was that by collecting samples separately for high and low fertility sites the statistical analyses carried out in chapter 5 were strengthened by decreasing within group variances.

In total, topsoil samples were collected for 50 plots cultivated by the case study individuals selected for the agricultural study, as well as for 18 sites that had not been cultivated for at least 20 years but often much longer. Approximately the same number of samples were taken in both villages. In the majority of cases, two samples per plot or uncultivated location were taken, but in some case only one or as many as three samples were taken. One sample was taken in the case of a small plot size and three samples when a farmer indicated that the sampled plot had two parts that were considered very fertile for very different reasons (e.g., one site had been used for cattle paddocking while the other site had received a lot of household refuse over the years). Uncultivated locations were selected by informants in different parts of the village territory, but always outside the village center. They can thus be considered to belong to the same pool as the bush fields.

[28] As is noted in chapter 6 this farmer judgement is especially based on differences in soil organic matter, the prime source of soil fertility according to Gourmantché farmers.

Only sites that had been cultivated or could potentially be cultivated, but were for instance sacred, were sampled.

For each of the topsoil samples the occurrence of gravel was noted and texture was determined using the USDA procedures for finger texturing. In addition, the farmer was asked for the local soil name, the duration of cultivation or fallow and the reason why this site was of higher or lower fertility than the other sampled site of the plot. In the Wageningen University soil laboratory, a number of chemical analyses were performed for each sample following the laboratory's standard procedures (Houba *et al.* 1995). These analyses measured nitrogen and phosphorus totals (digestion with H_2SO_2 – salicylic acid – H_2O_2 – Se), organic carbon (Kurmies-method) and available potassium (in a hydrochloric acid – oxalic acid extract), further referred to as K-HCl. To get an insight into the order of magnitude of a number of other chemical properties some further analyses were carried out for a limited number of samples. These were P-Olsen, the CEC (ammonium acetate method), EC_{25}, pH (the latter two in a 1:5 suspension of soil in water), and total potassium (digestion with H_2SO_2 – salicylic acid – H_2O_2 – Se). Based on the samples for which both P-total and P-Olsen were determined, a regression was done to be able to estimate P-Olsen on the basis of P-total. The formula *P-Olsen = 0.022 x P-total* was found with an R^2 of .85. The same procedure was followed for K-exchangeable (determined together with the CEC) and K-HCl leading to *K-exchangeable = 1.4084 x K-HCl* with an R^2 of .98. These regressions indicate that cheaper chemical analyses can be used to replace the more expensive analyses.

Aside from the topsoil samples a number of representative profiles were investigated. In both villages, profiles for the five most common local soil types as well as three less common soil types (one in one village two in the other) were studied. Pits of 1.20 meter deep were dug with the help of some villagers. Two soil scientists from the Antenne Sahélienne described and classified the profiles according to the French classification, while one of the researchers classified the texture and the soil type following the 1988 FAO classification (FAO 1988). Each of the horizons was sampled and the same laboratory analyses were carried out as for the topsoil samples.

Rainfall measurements

Rainfall measurements were carried out during the rainy seasons of 1996 and 1997 in each of the farming areas where the fields covered by the agricultural study were located. The purpose of these measurements was to facilitate interpretation of yield differences found through the yield measurements on the plots of the case study individuals. Differences in timing and amount of rainfall could help to explain yield differences, while the factor rainfall could be excluded in those cases where yield differences were observed without differences in rainfall. In addition, the rainfall measurements provided insight into the spatial variability of rainfall within the village territory.

The 15 required rain gauges were locally made because factory-produced ones went beyond the research budget. Using the rain gauge used at the Fada Meteorological Station as an example, two smiths in Fada N'Gourma were asked to weld gauges according to the French norms. Gauges were placed in each of the farming areas at sufficient distance from trees or places where tall grain crops would be grown. In cooperation with the villages, a villager who could read and write in either French or a local language was assigned to each of the gauges. Instructions were given on when and how to read the amount of rainfall using a measuring cylinder. A small notebook and a pen were provided so that the amount of rainfall could be recorded on a daily basis. On regular visits a research assistant would record the information from the notebook on a form, convert dates where necessary from the Gourmantché calendar to the French one, and convert the measurement of the cylinder into millimeters of rainfall.

Five gauges in Pentouangou and seven in Samboanli were first installed late May and early June 1996, slightly after the onset of the rainy season, so no records are available for the first showers of the 1996 growing season. In 1997 three more gauges were installed in Pentouangou. The largest distance between gauges was 5.5 km for Samboanli and slightly over 10 km for Pentouangou.

3.6 Conclusion

This chapter has presented the broad basket of research methods that, as was argued in chapter 1, is necessary to deal with the multifaceted nature of soil and water conservation. Only by working at multiple scales, with multiple data sources, and by mixing qualitative and quantitative research methods was it possible to generate the data, information, and insights that have allowed for the analysis presented in the chapters of part 2.

Extensive use was made of secondary information such as archival documents and statistical data. Still the major part of our data and information was derived from working with the population of the research villages (which led one villager to make the remark that is quoted at the beginning of this chapter). Especially on the part of the case study individuals a great deal of time and effort was required to allow us to collect all the necessary data. Vital to the success of this close collaboration has been the approach to working with villagers that was outlined in chapter 1, as well as the hospitality and friendship of the people we have worked with.

Part II *Soil and Water Conservation in a Changing Society: About Land, Technologies, and People*

4. The setting: a changing society

> In the beginning there was a river. The river became a road and the road branched out to the whole world. (Ben Okri, The Famished Road, 1991)

This chapter introduces the research area and the research villages. As such, it provides the geographical and historical backdrop to the empirical analyses in chapters 5 through 8. This chapter is especially important in the sense that it sketches the historical developments in the research area since the late nineteenth century and in this way helps explain patterns observed in the subsequent chapters.

The chapter begins, in section 4.1, with a brief introduction of the country and the geographic location of the research area. Section 4.2 describes the natural environment. This is followed, in section 4.3, with a presentation of the ethnic composition of the population and the population trends experienced over the last century. Sections 4.4 and 4.5 deal with the French colonization of the research area and the impact this had on livelihoods and agriculture. In section 4.6, the social organization and the livelihood system are discussed including crop cultivation and livestock ownership. The history of development interventions in the research area is the topic of section 4.7. Next, in section 4.8 the research villages are introduced and the differences between the villages are discussed. The chapter ends with a conclusion in section 4.9.

4.1 Burkina Faso and the research area

Burkina Faso, gaining independence from France in 1960 as Upper-Volta (Haute-Volta), is one of the world's 14 poorest countries in terms of its GNP per capita of US $240 in 1998 (World Bank 1999). It has few important mineral reserves, is land-locked and has a harsh climate that ranges from arid in the north to sub-humid in the south. Agriculture forms the main source of subsistence for the vast majority of the population (87% in 1994, World Bank 2000) and, as industries are few, agriculture is responsible for over 50% of the country's export revenue (MARA 1997a). With a total population of 10,312,600 inhabitants in 1996 (INSD 1998) it is one of the most populated countries of the West African Sahel.[29] In terms of the total population, it only comes second to the more than four times larger Mali (FAO 2000). Covering an area of some 274,000 km^2 it has an average population density of 38 inhabitants per square kilometer. With a rural population of around 8.7 million, the rural population density of almost 32 inh. km^{-2} is, in the West African Sahel,

[29] According to the 1985 population census some 9% of the Burkinabè live outside Burkina Faso, the vast majority in Ivory Coast; in reality these figures are probably much higher (Laclavère 1993).

only surpassed by Cape Verde and Gambia (INSD 1998; FAO 2000). Burkina Faso is bordered by Mali in the west and north, Niger in the east, and Benin, Togo, Ghana and Ivory Coast in the south.

The research area corresponds to Burkina Faso's eastern region and consists of Gourma, Gnagna and Tapoa provinces (see maps 1 and 2). The eastern region borders on Niger, Benin and Togo. More strictly defined, the research area is made up of Gourma and Gnagna provinces, the two provinces in which the research villages are located (chapter 3). A recent administrative reform (1996) created 15 new provinces and subdivided Gourma province in a Komondjari, Gourma, Kompienga and Koulpelogo province.[30] Because this division is incompatible with historical statistical data we will follow the old administrative division (dating from 1984) that divided the country in 30 provinces.

The eastern region covers an area of approximately 50,000 km^2 that extends roughly from 0°20' West to 2°20' East and from 11° North to 13°30' North and comprises 18% of the national territory. In terms of the general poverty and reliance on agriculture the eastern region does not deviate from the rest of the country. There are few towns. Apart from Fada N'Gourma (close to 30,000 inhabitants in 1996), the capital of Gourma province as well as of the eastern region, the only other town in the region is Bogandé, the provincial capital of Gnagna province, with almost 9,000 inhabitants (INSD 1998). In other words, the vast majority of the more than 900,000 inhabitants of the eastern region that were counted in 1996 lives in the countryside and engages in arable farming and livestock raising activities for a living.

4.2 The natural environment

4.2.1 Climate, geology, geomorphology and soils

In climatological terms the semi-arid eastern region is representative of the central portion of the country. With mean annual rainfall levels ranging from around 900 mm in the south down to some 600 mm in the north it is neither as dry as the northern part of Burkina Faso, nor as wet as the southwest. There is a single summer rainy season from May until September. Average daily temperatures range from 24°C in December-January to 34°C in March-May, with a daily amplitude of 10° to 15°C (CRPA de l'Est 1992). The northern part of the region falls in the Sahelian and the southern part in the Sudano-Sahelian ecological zone.

Geologically speaking, the eastern region is, just as most of the country, very old, consisting largely of the Pre-Cambian basement complex. In most cases this basement complex consists of syn-tectonic granites and migmatites, while there are some places with post-tectonic alkaline granites. In addition there are several SSW-NNE oriented bands of rocks of a very mixed nature, ranging from schists and quartzites to rocks of volcanic origin, dating back to the Birrimian period (CRPA de l'Est 1992; Laclavère 1993). It is especially the latter bands that are responsible for most of the relief in the area, often in the form of laterite caps. Aside from these laterite hills that rise some 100 to 150 meters from

[30] The Koulpelogo also covers a few departments that used to belong to the Boulgou province.

the landscape, there are a few granitic batholith outcrops dominating the view. Most of the area consists of flat to gently undulating peneplain, with slopes of 1 to 2% and an altitude of 100 to 400 meters above mean sea level (CRPA de l'Est 1992; Laclavère 1993). The one exception is the Gobnangou escarpment (see map 2), in the extreme southeast of Tapoa province that consists of more recent sedimentary rocks (Laclavère 1993). In geomorphological terms the eastern region differs little from the rest of the country, which is not surprising given the similarity in geology and climate.

Soil wise the region is also far from exceptional. As in the rest of the country, soils are generally limited in their physical and chemical fertility because of their limited depth and/or heavily weathered nature. The main soil types that can be discerned according to the French classification (CPCS 1967) are the "sols peu évolués d'érosion sur matériau gravillonaire", the "sols ferrugineux tropicaux peu lessivés et lessivés sur matériau sableux, sablo-argileux et argilo-sableux", the "sols bruns eutrophes tropicaux sur matériau argileux", and the "vertisols sur alluvions ou matériau argileux". Finally there are two soil types that occur in small areas throughout the region, the "sols minéraux bruts: lithosols sur roches diverses et cuirasses", found on the laterite and granite hills and the "sols hydromorphes minéraux à pseudogley sur matériau à texture variée" found in bottomlands.[31] The later two soil types occur over more extensive areas in the Gobnangou area bordering Benin (Laclavère 1993). In terms of the revised FAO legend (FAO 1988) the following main soil types can be discerned: Lixisol, Luvisols, Cambisols, Vertisols, Regosols, Leptosols, and Planosols. With few exceptions the soils have a low chemical fertility with a limited availability of exchangeable cations and low levels of organic matter. In addition, many soils are limited in depth by either bedrock, or, more commonly, gravel and lateritic formations. They are also suffering from sealing, crusting and hardsetting (Hoogmoed 1999).

4.2.2 Land use, flora, and fauna

The flora of the eastern region is typical of the Sudano-Sahelian zone, with savanna woodlands in the south, and tree and bush savannas towards the north. Typical tree species occurring throughout the region are the shea tree (*Butyrospermum parkii*), the locust tree (*Parkia biglobosa*), the mahogany tree (*Khaya senegalensis*), the baobab (*Adansonia digitata*) and various acacia species. According to CRPA de l'Est (1992) the most important vegetation formations in 1988 in Gnagna province were the dense tree savanna (54%), the not-so-dense tree savanna (28%), and the dense bush savanna (12%). For Gourma province (excluding protected areas) these were the dense bush savanna (33%), the not-so-dense tree savanna (21%), and the dense tree savanna (20%). In both cases, gallery forest occupied around 1% of the area, while denuded areas were almost negligible. At the time, the total area under crops was estimated at 14% for Gnagna and 5% for (the unprotected part of) Gourma province. Based on the average cultivated area for 1993 to 1996 derived from the agricultural statistics provided by MARA (1995b, 1996a, 1996b, 1997b) and the provincial

[31] Bottomland refers to the lowest part of a broad valley and includes (ephemeral) drainage courses and the, occasionally flooded, land surrounding them.

areas calculated from ADDS (1998b) cultivated areas for Gnagna, Gourma, and Tapoa provinces in the mid 1990s are, respectively, 15.2%, 4.5%, and 7.1%. For comparison, the average for the Central Plateau[32] is 16.8% while the national average is 12.3%.

Until well into the twentieth century, the eastern region was rich in terms of fauna. Today the occurrence of the larger fauna such as lions, elephants, buffaloes, gazelles, and antelopes is largely limited to the national parks. Of the whole country the eastern region has the largest proportion covered by national parks and reserves, most of which date from the mid 1950s (MFP 1993). In Tapoa province there are three protected areas, together occupying 3620 km^2 or 25% of the provincial area, while Gourma province has four protected areas that cover a total area of 5488 km^2 or more than 20% of the provincial area.[33] In Gnagna province there are currently no national parks or reserves. The parks and reserves are popular among wealthy foreign visitors for hunting. Several hunting camps host such visitors during the dry-season and offer fully accommodated hunting safaris. Such hunting safaris date back to at least the 1960s and have done much to decrease the wildlife population. The Gourmantché themselves were also renowned hunters, working with wildlife traps, bows and arrows and later also with guns. Wildlife had an important place on the Gourmantché menu during pre-colonial and early colonial times. Serre (1952), who studied the consumption patterns of 17 families at three localities in May-June 1951 noted that the Gourmantché consumed more meat than any of the other studied ethnic groups and that in 14% of the cases this was wildlife. Which indicates that wildlife was still relatively common at the time. A very important factor in the diminishing wildlife population, especially outside the nature reserves, has been the reduction in habitat caused by the growth of human and livestock populations and the expansion of the cultivated area.

4.3 The population

4.3.1 Ethnic and religious composition

The eastern region (see map 2) is the traditional territory of the Gourmantché ethnic group. Other important groups that live in the area are the Yaama (southwest of Fada N'Gourma in the area of Komin-Yanga, Yondé and Soudougui) and the Zaosé (west of Fada N'Gourma in the area around Diabo and Tibga). In their customs and language the Yaama are more closely related to the Mossi than to the Gourmantché. The Zaosé have an origin that can be traced back to various ethnic groups such as the Bissa, the Yaama, the Gourmantché and the Mossi (Madiéga 1993). Finally, there are the Fulbe and Rimaïbè (agro-)pastoralists, who live throughout the area.[34] As can be determined from various colonial censuses that

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[32] Here defined as the provinces part of the following CRPAs: Centre, Centre Nord, Centre Est, Centre Ouest, Centre Sud, and Nord.

[33] In Tapoa province the protected areas are: the Parc national du W (which continues across the borders in Niger and Benin), the Réserve partielle de la Kourtiagou, and the Réserve totale de faune d'Arly. In Gourma province these are: the Forêt classée de Madjoari, the Réserve totale du Singou, the Réserve partielle de Pama, and the Réserve partielle de faune d'Arly. There are a few villages located in the latter.

[34] The Fulbe are also known by the names Fulani (in some English language literature) and Peul, Peuhl, or Peulh (in French language literature). The Rimaïbè have their origin as former captives of the Fulbe.

took place between 1919 and 1930, the Gourmantché made up some 60% of the population of the Cercle de Fada, the Mossi, Zaosé, and Yaama together some 30%, the Fulbe some 5% and the Rimaïbè some 2% (RAP.INS.19/38; RAP.INS.24; RAP.INS.31).[35] These proportions have not changed much since. There are, however, important historical differences between the individual provinces. According to a 1991 demographic survey (INSD 1994), 82% of the inhabitants of Gnagna province are Gourmantché, 11% Mossi (including Zaosé and Yaama), and 6% Fulbe (including Rimaïbè). For Gourma province these figures are respectively, 55%, 35% and 8%. Other ethnicities and foreign nationalities make up 1 to 2% of the total population.

In recent years the ethnic balance may have begun to shift, as the drought of the mid 1980s has led to an increased influx of Mossi from the densely populated Central Plateau, especially to the relatively sparsely populated parts of the rural Gourma province. Between 1985 and 1991 almost 1000 persons migrated from the Mossi provinces to Gnagna and more than 6500 to Gourma province. For Gourma province this figure amounts to 12% of the population increase between 1985 and 1991. In reality the number of immigrants is probably much higher because several new, unrecognized villages and bush camps were established south of Fada N'Gourma by these immigrants and are likely to have been missed by the 1991 demographic survey as they did not yet exist during the 1985 census.

In the 1930s the vast majority of the Gourmantché population practiced traditional religions, less than 3% was Muslim and just a handful had converted to Christianity (RAP.INS.31). Since then the number of Christians and Muslims has grown considerably. In the 1991 demographic survey (INSD 1994) only 30% of the population indicated practicing a traditional religion, 30% stated to be Muslim, and in Gnagna 15% said to be catholic and 21% protestant, while for Gourma province the latter figures are respectively 24% and 7%. The value of these figures is however doubtful as many people practice both a traditional religion and a "modern" one. The fact that 9% in Gourma province was registered as not practicing any religion at all also casts a serious shadow on the validity of the figures as this is probably more indicative of the difficulty in dealing with such questions in a survey than of actual practice (almost half of the nation's non-believers would be living in the rural Gourma!).

4.3.2 Population growth and density

There has been a strong population growth in the course of the twentieth century as can be seen in figure 4.1. While the population has been remarkably stable during the colonial period, with an average annual growth of 0.5%, a strong average annual growth of 4% can be observed after independence (table B.1 in appendix B). This pattern can be explained by various factors. Whereas during the colonial period epidemics, forced labor, heavy taxation, out migration and recruitment for two world wars had taken their toll, the standard of

[35] The borders of the former Cercle de Fada correspond more or less to those of the present eastern region of Burkina Faso.

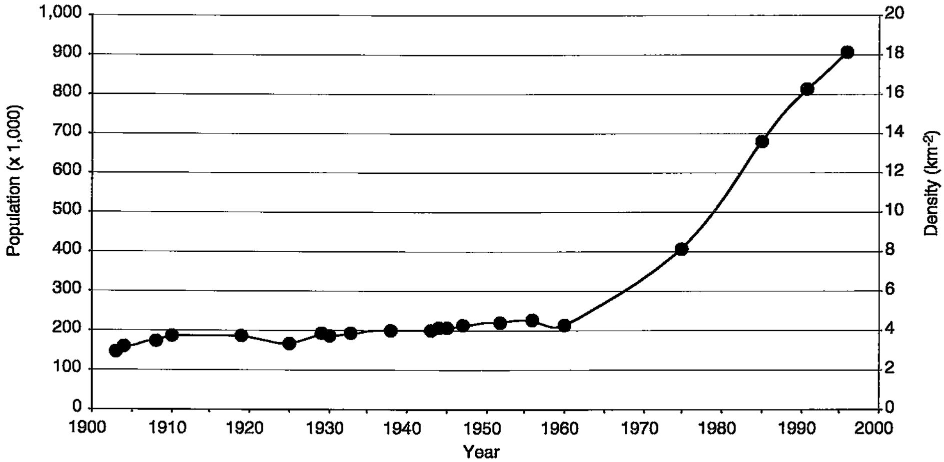

Figure 4.1. Total population in Burkina Faso's eastern region (1903-1996)
Source: Table B.1 in appendix B.

living, medical facilities and security improved considerably after independence.[36] On the other hand, the repressive colonial policies and lack of administrative personnel during the colonial period have undoubtedly contributed to an underestimation of the population during that period, a view that is also expressed by Picanon in his 1925 inspection report (RAP.INS.24). Inhabitants had many reasons to evade counting for fear of the head tax and labor and army recruitment, while at the same time the vast area and the proximity of international borders made it relatively easy for them to escape. The 1960-61 demographic survey obviously still suffered from these fallacies as people still had the negative associations with enumeration and because it was based on prior administrative data combined with a limited field sample (Haute-Volta 1970). While far from perfect, as vast areas need to be covered with limited means, later censuses are likely to have become increasingly accurate. Whatever the inaccuracies of especially the figures from the first half of the twentieth century, the general trend of slow growth until the 1960s and rapid growth thereafter, is likely to reflect reality and matches that of national level statistics.

The population densities have also steeply risen from some 3 inhabitants per square kilometer in 1903 to some 18 in 1996 (RAP.MON.03; INSD 1998). However, the population is not equally distributed over the area. Gnagna province is much more densely populated than Gourma and Tapoa provinces. While not as densely populated as some of the provinces on the Central Plateau, the mostly Sahelian Gnagna province is, with 35 rural inh. km^{-2}, above the national average of 30 rural inh. km^{-2} for the Sahelian ecological zone.[37] In contrast, the Sudano-Sahelian Gourma and Tapoa provinces are, with

[36] The 1960-1961 demographic survey revealed that with 35.5 per 1000 inhabitants, Gourma had the highest general mortality of the country (INSEE n.d.: 43).

[37] Unlike the figures for the research area, national averages per ecological zone were not derived from rural population figures from the latest (1996) census, because this, unlike all other available data, follows the new administrative division (section 4.1). These numbers are therefore based on the agricultural population as recorded

Table 4.1 Population density for the eastern region in 1996

Province	Rural density	Total density	Real total population density[a]
Gnagna	34.5	35.5	46.7
Gourma	12.9	14.0	20.3
Tapoa	16.2	16.2	>21.5[b]
Total	*17.7*	*18.4*	*>25.6*[b]

Source: Table B.2 in appendix B.

[a]Real total population density corrects for protected and uncultivable areas.

[b]Because no data was available on the uncultivable area of Tapoa province this aspect could not be taken into account in calculating the real total population density.

respectively 13 and 16 rural inh. km^{-2}, relatively sparsely populated compared to the national average of 34 rural inh. km^{-2} for the Sudano-Sahelian ecological zone (calculated from MARA 1996a; ADDS 1998b; INSD 1998).

The population densities in Gourma and Tapoa provinces seem lower than they really are because, as was noted earlier, these provinces have some of the largest protected areas of the country (see section 4.2.2). Another factor that needs to be taken into account when interpreting population density figures is the ratio of cultivable to uncultivable land. CRPA de l'Est (1992) offers an analysis of the agro-pastoral potential of Gourma and Gnagna provinces (excluding protected areas) based on aerial photo interpretation, the 1:500,000 soil map made by ORSTOM (Boulet and Leprun 1969), and limited field verification. It is possible to make an approximation of the cultivable area in both provinces based on this study. CRPA de l'Est considers areas covered by lithosols (such as laterite caps), very superficial ferruginous tropical soils and solonetz as uncultivable, the first two primarily because of soil physical constraints (extremely limited rooting depth), and the latter because of a high salinity. On these grounds, 24.0% of Gnagna province and 12.5% of Gourma province is considered uncultivable. Given the fact that these calculations are largely based on remote sensing and a small-scale soil map, these figures can only be seen as rough estimates, especially as CRPA de l'Est reports that in certain areas some cultivation does currently take place on these soils.

Table 4.1 compares rural, total, and real total population densities. The latter take protected areas (section 4.2.2) and uncultivable areas into account. As can be seen from the table, real population densities are much higher than a simple division of population by area reveals. They range from just over 20 inh. km^{-2} in Gourma province to almost 47 inh. km^{-2} in Gnagna province. In practice local densities can be even higher as the population is not equally distributed over the area.

Already at the arrival of the French, the western part of the area, bordering on the Mossi, had a much higher population density than the east and south (RAP.MON.03). This pattern is also clearly visible in figure 4.2 that presents a comparison of the rural population densities in 1933 and 1996 in what are today called Gnagna and Gourma provinces. The figure shows that there has been a very strong population growth, especially in the

in a 1993 agricultural survey (MARA 1996a). For practical purposes rural and agricultural population figures can be considered comparable for Burkina Faso (MARA 1996a: 24).

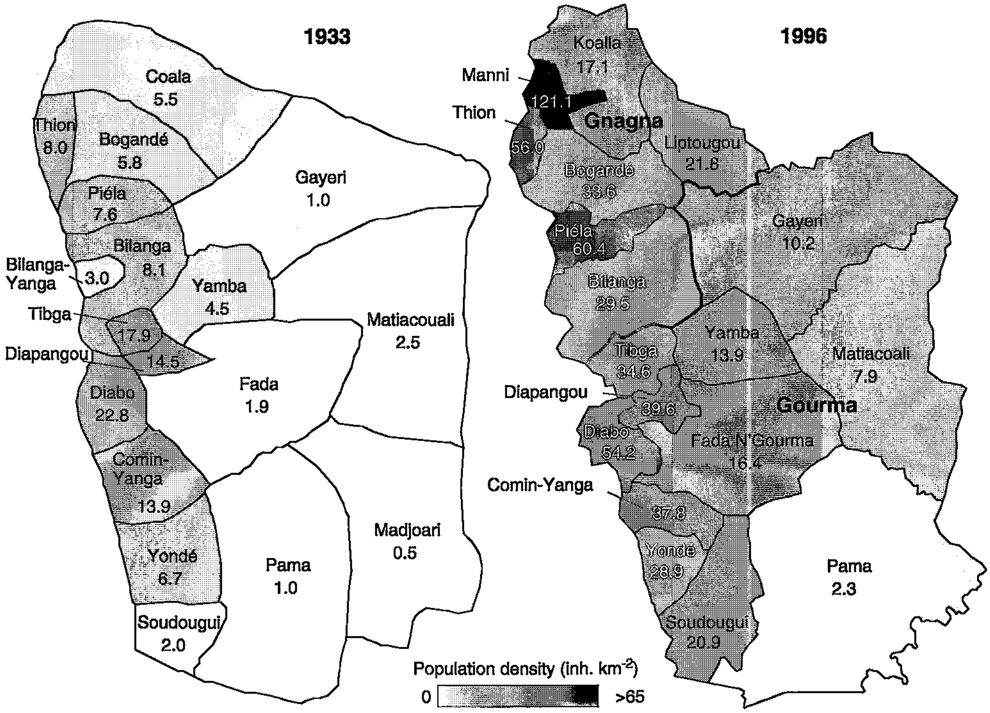

Figure 4.2. Rural population densities in 1933 and 1996 for the departments of Gnagna and Gourma province
Source: Data are derived from Table B.4 in appendix B. Canton boundaries for the 1933 map are based on a 1941 sketch map in RAP.MON.41. Departmental boundaries for the 1996 map come from ADDS (1998a).

northwestern part of Gnagna province where the population density is currently much higher than in most of Gourma province. Some Gnagna departments have even surpassed the densities in the western part of Gourma province that was historically the most densely populated section of the Cercle de Fada.

4.4 The French colonization of the Gourma kingdom

Burkina Faso, known as Upper-Volta (Haute-Volta) until 1984, was colonized by the French between 1895 and 1898. It was a classical case of the scramble for Africa, in which French expeditions set off to reach the interior before those of competing countries. A French expedition, led by Commander Decoeur and Lieutenant Baud, set off from the coast of Dahomey (now Benin) towards eastern Burkina Faso, then known as the Gourma kingdom, the kingdom of the Gourmantché. The Germans joined the race, rapidly moving north from the coast of Togoland (now Togo). The German expedition led by Grüner and Von Karnap reached Pama (see map 2) just hours before the French mission from Dahomey, and after leaving a few guards behind, the Germans moved in the direction of Matiakoali where the supposed king of the Gourmantché had his base. When the French mission reached Pama they easily defeated the German guards and took over the village. Next, the French moved northwards towards Fada N'Gourma where Bantchandé, another king claiming ultimate authority over the Gourmantché was based. On 20 January 1895 the French Commandant Decoeur signed a treaty with Bantchandé that placed the area under French protection (Madiéga 1993; Balima 1996). Later an international commission met in Paris to discuss the partition of this part of Africa (La boucle du Niger). For the Gourma kingdom no conclusions could be drawn as both the Germans and the French claimed to have signed a treaty with the "real ruler" of the Gourma kingdom. In order to protect their claims both the Germans and French sped northwards from the coast again towards the Gourma kingdom. In January 1897 a French mission led by Captain Baud and Captain Vermeersch reached the Gourma kingdom for the second time and joined Bantchandé who had sought refuge in Diabo (see map 2). Joining forces with Bantchandé, a whole series of rebellious villages, including Diapangou, Tibga, Bilanga, Matiakoali, Diapaga and Maadaga were forced to surrender or simply burned down and ransacked between February and May 1897 (RAP.DIV.97; Madiéga 1993). In doing so the joint army of the French and Bantchandé collected a considerable loot in the form of confiscated or surrendered livestock and horses (RAP.DIV.97). Having effectively conquered the area, the French were now in a much better position to negotiate than the Germans. On 23 July 1897 an agreement was finally signed whereby the Germans accepted the French claims on the Gourma kingdom and renamed it "Cercle de Fada N'Gourma" (RAP.INS.31, annex 1).

Since it was colonized in 1897, the eastern region has been attached to several different colonies. While most of today's Burkina Faso was initially part of the French "Haut-Sénégal et Niger" colony, the Cercle de Fada N'Gourma was part of the colony of Dahomey until it was joined to Haut-Sénégal et Niger in 1907. In 1919 that colony was subdivided and the area became part of the newly formed Haute-Volta colony whose borders coincided more or less with those of present-day Burkina Faso. In 1932 the colony of Haute-Volta was dissolved and the Cercle de Fada N'Gourma became part of the Niger Colony, while the north of the country was joined to the French Sudan (now Mali) and the south and southwest to Ivory Coast. It was not until 1947 that Haute-Volta was re-established, gaining independence on 5 August 1960 (Madiéga 1996).

The eastern region has always been a typical frontier area. Not only did it fall under various jurisdictions during the colonial period, but it also lacked strong central authority in late pre-colonial times. There were wars with the neighboring Mossi in the west and the Fulbe kingdoms in the north as well as frequent armed disputes between neighboring chieftainships within the region (Madiéga 1993). Larger villages were often fortified with earth walls or thorn shrubs and people lived in large family groups. While the security situation changed for the better after the French "pacification", the control of the colonial rulers over the area remained very limited. Restricted in manpower, the French applied a system of indirect rule with a hierarchy of appointed local chiefs. At the top of the hierarchy there was the French Commandant de Cercle, followed by the provincial chiefs who in turn supervised the canton chiefs responsible for a number of villages chiefs. All but the village chiefs were selected by the French, but often based on traditional authority relations. At the onset, the king of Fada took a position between the French commander and the canton chiefs, but later his position was (at least officially) relegated from provincial chief to canton chief for the Noungou (the Gourmantché name for Fada N'Gourma) canton (Zuurd 1996). As the area was not central in the French interests, for lack of mineral reserves and having a low population density (3 to 4 inh. km^{-2}), it remained seriously understaffed with just a handful of Europeans serving in the public administration. Also after independence the area retained its frontier character. With its vast area, small population, and limited infra-structure, large tracts remain inaccessible during the rainy season unto this day. Public servants generally do not look forward to a post in this area because of the lack of amenities in anything but the regional capital, Fada N'Gourma.

4.5 Colonial repression and the impact on livelihood and agriculture

In Burkina Faso, and in particular in the eastern region the impact of colonialism is unlikely to have been as all embracing as in some other colonies. There was no large-scale settlement of European farmers that led to evictions and resettlement of the local population in native reserves, as happened in some East and South African colonies. In addition, lack of colonial interest in the eastern region and lack of personnel, did not allow the kind of large-scale cash cropping that was found in the West African coastal areas. This said, colonialism still profoundly affected the livelihoods of the local population.

4.5.1 Forced labor and heavy taxation

While the exact impact of army recruitment, forced labor and the head tax are not easily assessed, their impact was considerable. Officially every male adult had to work 10 days[38] per year on building roads, bridges, and for other public works, during the months February to April (RAP.INS.19/38, comment of the Commandant de Cercle). In oral histories informants, however, indicate that also women were employed for these purposes, that members of small families sometimes had to work multiple times per year, and that forced labor could be employed any time of year. There were various forms of forced labor. By far the largest category was unpaid labor (the so called "prestations") that was used for the maintenance and construction of roads, air fields, tree planting and various other activities.[39] Then there was the paid labor used to transport goods or for maintenance and the construction of buildings for the administration. Finally, only relatively small numbers of people from the Cercle de Fada were recruited for remunerated work on roads and railroads outside the Cercle, or even in neighboring countries such as Ivory Coast.

To give some indications of the number of people and workdays involved we will give some figures for 1922. In that year 32,496 men were called to work 259,960 days (an average eight days per person) for free, 174 men were called for military service, 1,325 men were called to transport goods during 15,796 days (12 days per person) for pay, and finally 2,580 men were called for large public works in Ouagadougou and 207 men for paid work on the railroad in Ivory Coast in both cases for a period of six months, excluding travel time (RAP.INS.24). This implies that in 1922 36,780 men of a total Gourmantché and Mossi population of some 150,000 persons worked at least eight days for the colonial

[38] During some years this was eight days.

[39] Certain categories of people were allowed to pay a specific amount of money instead of performing the labor service.

authorities, in the vast majority of cases without being paid and in virtually all cases involuntarily (RAP.INS.31). If we consider that about half the population is male and a little less than 75% is between 15 and 50 years of age, this means that about 2/3 of the able-bodied men were called for work during a single year according to the official statistics. The reality was much worse however.

In his 1931-1932 inspection report, Bernard Sol, first class inspector of the colonies, paints a very grim picture of the situation. In his view, on paper the amount of days required for construction and maintenance of public works were simply equaled to the labor force available according to the official regulations and the information from the latest census, while in practice all work had to be carried out in full, irrespective of the available amount of labor days on paper (RAP.INS.31, p. 33). Based on his observations and on the amount of work that had to be done on a yearly basis, he estimated that at least twice the official amount of working days were required and therefore carried out. This is not surprising, given the length of the road network (1100 km) that needed to be maintained and the equipment that was available: calabash, wooden stick and hoe, all supplied by the workers themselves. What is worse, Sol (RAP.INS.31, p. 35), confirming our oral histories, reports that, against all regulations, children and women were also employed for forced labor: "... à ravitailler les chantiers en eau qu'ils vont à coups de calebasse chercher souvent à plus de 10 kilomètres. Ce qui ne les empêche pas, dans l'intervalle de ces ravitaillements, de travailler aux terrassements".[40] Food, which officially had to be supplied by the authorities for anyone working more then 5 km from home, was left to the concern of the workers, while the rule that no-one had to work outside their own canton was completely ignored. Finally, the road maintenance works observed by Sol did not take place in the slack season, but immediately after the end of the rains, in November, right in the middle of the crop harvest. In other words, forced labor affected everyone, irrespective of gender or age, for much longer periods then the official 10 days at distances of many days walking from home, during crucial periods in the agricultural calendar, and under miserable circumstances in terms of the availability of food and water and the equipment at hand. These practices thus led to an increased morbidity and mortality of the population, both directly because of the work conditions and indirectly because food production was undermined. It may also have stimulated the increased involvement of women in agriculture (see section 4.5.3).

The population was similarly afflicted by the head tax (during the 1920s applicable for everyone eight years and older), the requisition of food for the personnel of the administration, the tax on horses and other livestock and the tax on import and export of animals and goods. At a meeting of the conseils de notables on 30 April 1930, Simandari (paramount chief of the Gourmantché), when asked by the Commandant de Cercle whether the head tax could be increased slightly for 1931, complained that the head tax had more than doubled (from 3 Frs. to 8 Frs.) between 1925 and 1930, notwithstanding that the situation in the area had not changed: "Les Gourmantchés sont restés uniquement

[40] This roughly translates to: "... to provision the work sites with water, which they collect in calabashes at distances of often more than 10 kilometers. This does not prevent them, in the interval between these trips, to work on the excavations."

cultivateurs et n'ont d'autre ressource que de vendre leur mil aux peulhs ou aux voyageurs. Si l'argent ainsi obtenu n'est pas suffisant pour payer l'impôt les hommes valides partent en Gold-Coast pour s'en procurer. Beaucoup ne reviennent plus" (RAP.INS.31, p. 28).[41]

4.5.2 Stimulating cash crops and control over the agricultural production

The colonial authorities sought to increase the profitability of their colonies by stimulating the cultivation of certain crops. In practice, stimulation, for much of the first half of the twentieth century, meant forcing cultivation of those crops. After the abolition of forced labor in 1946 a steep increase of the taxes was employed for this same purpose (Lankoandé 1991: 61). The main interest of the authorities of the Cercle de Fada N'Gourma was the promotion of cash crops, notably groundnuts and cotton, both of which had been grown in the area already during pre-colonial times (RAP.MON.03). To a lesser extent attempts were made to induce the population to harvest greater amounts of certain commercially interesting bush products such as kapok, shea nut, and honey (RAP.POL.10). Finally, the cultivation of several food crops, such as cassava, rice, cowpeas, and potatoes was also encouraged.

Of all the promoted crops, cotton was probably the most sought after. In 1910, Commandant de Cercle Duranthon reports that cotton is an important crop in the northern and eastern parts of the Cercle, firstly, because it forms the basis for a number of artisan activities and secondly, because of the trading with Say, Niamey and Dahomey (RAP.POL.10). Henry (1906) not only notes that especially in the area near Diapaga a lot of cotton is grown, but also sees a bright future for cotton in the southern part of the Cercle de Fada N'Gourma, if the production is stimulated through proper outlets. The administration, however, decided to increase the cotton production through force. Bernard Sol, critical as ever, writes about the "question du cotton" in his inspection report (RAP.INS.31): The population was obliged, through their chiefs, to grow a certain amount of cotton. Sale of the production was prohibited outside the periodic markets controlled by the administration. In theory the price was determined by the free market, in practice there was just a single corporate buyer and after having traveled hundreds of kilometers with a load of cotton no-one was ready to refuse the extremely low price and carry back the cotton to the village chief that had commissioned them for the job. Cotton never really took off on a large scale in the eastern region, despite repeated efforts of the administration. As late as May 1995 the president of the republic, Blaise Compaoré, in need of foreign currency, visited the region to personally incite farmers to produce more cotton. His plea fell on deaf ears as farmers all too vividly remembered earlier campaigns that ended in debts for those whose harvest had been insufficient to repay their loans for seeds and fertilizer (interviews in the research villages). Those that did participate were discouraged by the price disparity between expensive inputs and the low price paid by SOFITEX (Société Burkinabè des Fibres Textiles) for the harvested cotton. Also the fact that it took many months before all

[41] This roughly translates to: "The Gourmantché have remained farmers and do not have other possibilities than to sell their millet/sorghum to Fulbe or travelers. If the money thus obtained is not sufficient to pay the tax, the able-bodied men go to Gold-Coast to earn some. Many do not return."

the cotton was collected and paid for by SOFITEX troubled farmers who saw their cotton going to waste and, in addition, for lack of payment were unable to buy cereals when they were cheap, just after the harvest (Labidi 1997). The much less input demanding groundnuts, however, became an important crop especially in Gnagna province, where today some 20% of the cultivated area is covered by groundnuts (see section 4.6.3).

Apart from the colonial quest to have the region produce more cash crops, the colonial administration also tried to control the production of the main food crops: millet and sorghum. Already early on, the French administration introduced the concept of the "grenier de réserve", which the farmers were supposed to construct to communally store a part of their harvest in, as a reserve for times of food shortage or famine. Of course it was the colonial administration that decided when the grain could be accessed and how much people had to pay to access this reserve stock (Lankoandé 1991). Getting those granaries filled and keeping them filled was a constant preoccupation of the subsequent Commandants de Cercle (Zuurd 1996: 28).

4.5.3 The long-term impact of the colonial practices

The colonial labor and taxation practices could not but have a strong impact on the livelihoods of the population. The circumstances under which forced labor was carried out and the detraction of resources away from own food production took an immediate toll in terms of death and disease that, judging from the population trends discussed in section 4.3, probably undercut the benefits of an increased security in the area after French "pacification". Colonial practices, however, also had very different kinds of effects. A number of long-term processes of social change were set in motion or sped up, which can at least partially be attributed to the colonial policies and practices. Broadly speaking three areas of social change can be distinguished: mobility, authority, and the organization and monetization of production.

In terms of mobility, several important effects of the colonial practices can be recognized. The relative peace, introduced by the French occupation after a period of general unrest in the area, facilitated trade and travelling. In addition, during the colonial period, especially men often had to travel long distances to meet all the colonial obligations. People not only traveled within the Cercle, but the colonial occupation also laid the basis for temporary and permanent migration to neighboring countries (or in the case of army recruitment to Europe, North Africa and even Indo-China). This kind of migration had two causes, recruitment for public works for the colonial authorities, in for example Ivory-Coast, but also attempts to flee labor and army recruitment and the head tax. In the latter case, Ghana (then called Gold-Coast) was a popular destination because of its proximity to the Cercle and because of the (most of the time) much less oppressive regime of the British colonial authorities. The issue surfaces time and again in the colonial reports (e.g., RAP.INS.31). The experiences during the colonial époque probably laid the basis for the relatively high mobility that continues to this day, whereby youngsters, travel to Niger, Togo and Ivory Coast to earn some money and see something of the world (chapter 8). The increased mobility also implied that people increasingly met people and observed situations outside of their own realm. From interviews it is clear that this has been an important basis for the diffusion of agricultural innovations such as new landraces (chapter 8).[43]

Another important change in mobility that took place in the course of the twentieth century is the mobility of the home: the village level mobility of late pre-colonial times has gradually been replaced by compound level mobility. When the French arrived at the end of the nineteenth century the security situation was such that people stayed together in their villages cultivating in the immediate vicinity (Senechal 1970: 110-111). From time to time the whole village would move to a new location if some misfortune had befallen the population in the old location, or if water or soils had become exhausted (Remy 1967: 31, 37; Senechal 1970: 86-87). With the colonial occupation of the area the security situation changed for the better, as warfare and slavery were put to an end. At the same time the pressure on the population was increased in the form of recruitment and taxation. These two factors were a stimulus for the population to spread out and establish rainy season bush camps as well as more permanent new wards, often at considerable distance from the village center, so as to evade recruitment and taxation (Cartry 1966: 69; Remy 1967: 46-49; Senechal 1970: 95-96). This was not at all appreciated by the colonial authorities who incited the village chiefs to keep their population in place, at least during the dry season, in order to facilitate counting and taxation (RAP.TRI.34). These observations are confirmed by oral histories in the research villages, Toumbengu Thiombiano, born in 1918, for instance reports:[44]

> Before the arrival of the [French] military there were no bush camps. Anyone who would try to live in a bush camp would be eaten by wild animals or be taken captive by a warrior. During the days of my father, people would cultivate and return to the village at night. It was at the time that Simandari took the throne [1911] that people started having bush camps. It was because of the forced labor. When the forced labor started, people tried to escape far away in the bush. It was not because the soils near the village were exhausted, it was because of the coercion.

According to Remy (1967: 46-49) the dispersion of the villages became particularly strong after the second World War and he notes that in 1962 almost 70% of the population of his study village, in the Gobnangou area, lived in bush compounds during the rainy season. The importance of rainy season bush compounds continues to this day, though the proportion of the population that lives outside the village center during the rainy season varies considerably from village to village (20% to 90%). In other words, cultivation in bush compounds has become an important aspect of the agricultural system with important agricultural and social implications that are dealt with below (see also chapter 8).

The dispersion of the villages also has an important political component. It has led to a decline in power of the traditional authorities and is at the same time a symptom of such a decline. During the colonial period village chiefs were caught in-between the interests of the colonial authorities and the population. They were the ones who received orders

[43] Landraces are sometimes erroneously referred to as varieties.

[44] Interview on 24 February 1997, Pentouangou.

(through the canton chiefs) from the colonial administration and had to make sure that recruits met their obligations, that counting took place and that taxes were paid. This meant that the village chief was held responsible by the authorities for the compliance of his subjects and had to decide at the village level who was going to supply the requested labor and so forth. This situation clearly undermined their authority, at least among part of the village population, and led to the establishment of bush camps, new wards and eventually new villages. This dispersion of the compounds in turn further augmented the decline in authority. While the independence of the colony in 1960 is likely to have stalled the decline in authority to some degree, the anti-traditional authority politics of Sankara's regime (1983-1987) led to a further decline. Today the authority of the village chiefs varies considerably from village to village depending on the local history, the importance of the family of the chief, his personal qualities and the attitude of the population. In all cases authority is shared with a délégué administratif who acts as an intermediary between the village and the administration and is a villager appointed by the head of the district (préfet) (Lekanne dit Deprez 1995). In general the délégué administratif is a respected person from a respected family.

Village chiefs were not the only ones suffering from a decline in authority. The authority of the compound head was also seriously undermined by all the changes taking place during the colonial époque that affected the social organization of village live. Traditionally, the population had lived in large compounds in patrilineal extended families usually comprising one production unit (Senechal 1970: 95).[44] The members of the compound worked on the large communal fields under the supervision of the compound head who was responsible for the livelihood of the whole compound. With the creation of rainy season bush compounds and through the formation of new wards, large compounds typically split up into smaller units, as new compounds were established and households claimed more independence, reducing the authority of the compound head. Having worked and lived more or less independently during the rainy season it was much more difficult for heads of household to return to the village in the dry season and accept the authority of the compound head again. At the same time, the rainy season split-up was much easier to accept by the compound head than the establishment of a new compound within the village (Cartry 1966: 70). Another important factor in the breakup of the large compounds was that it was primarily the younger members of the compound who were sent to work on the roads for the French or were recruited for the army. And, when money to meet the ever increasing head tax had to be earned, it was not the head of compound who set out on migration to Gold Coast (now Ghana), but younger men. This way, fathers became increasingly dependent on their sons and their own younger siblings. All these factors contributed to a break up of the large compounds into smaller compounds with a smaller number of households. It is possible that at first the compound heads stimulated the break up into smaller units as Senechal (1970: 97) and Remy (1967:46-49), each through a different argumentation suggest, but it is unlikely that they were pleased with the impact on their

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[44] Based on field work in the early 1960s Cartry (1966: 68) notes that already for a longer time there had been certain compounds that were composed of more than one production unit.

authority on the long-term. Just as the cultivation in bush camps, the split-up into smaller units has had important effects on agriculture and the organization of labor (chapter 8).

With the collapse of the traditional power structures and the split-up of the large compounds into smaller units there has been an increased individualization of agricultural production and consumption. There has been a shift from compound level organization of production and consumption to the household and even sub-household level (see next section). In addition, the role of women and children in agriculture has increased. While in the beginning of the twentieth century women had few agricultural obligations apart from producing sauce ingredients, they now not only spend more time cultivating on their husband's fields, but also have fields of their own. This process can be traced back to the second half of the twentieth century (see chapter 8 for further details). Today even young children have their own little fields that get bigger as they grow older.

The individualization of production has also been very much influenced by the increased monetization and commercialization that was pushed by the colonial authorities. When the French arrived there were several trade routes that cut across the area on their way from the desert fringe to the coastal countries. This long-distance trade was largely in the hand of other ethnicities such as the Hausa and the local markets were relatively small and unimportant (RAP.TOC.15/228). At the turn of the twentieth century the most important export product of the region was livestock, while kola nuts, salt and fabrics were the most important import products (Lutgendorff 1997: 19). In most ways the population was however largely self-sufficient, making their own pottery, having their own blacksmiths and producing their own food. In 1915, Commandant de Cercle Duranthon (RAP.TOC.15/228), for instance, notes that the markets were rarely visited after the end of January when tax collection had generally terminated.[45] In his opinion the population produced just enough to live and to pay the taxes. Through an ever increasing head tax the colonial administration sought to stimulate trade and the commercialization of agricultural produce by creating a demand for money (to pay the taxes). Much to their dissatisfaction this took a long time because of the high degree of self-sufficiency and because the population was reticent towards the French coins and notes and continued using cowries well into the 1930s (Zuurd 1996: 23-24). In the long run the colonial authorities succeeded both in an increased monetization of the society and commercialization of the agricultural produce. Both of these issues and their effect on agriculture are dealt with in more detail in chapter 7. What is important at this point is that in some parts of the area, probably at least partly due to the poor infra-structure, it took until well into the 1970s before western goods such as flashlights and second hand clothes fully penetrated the local lifestyle and part of the agricultural production became market oriented. Today, the eastern region has some 180 smaller and larger markets, as well as 25 livestock markets (INERA 1993: 24-25). Most markets operate every three days, except for the very large ones which are daily or the livestock markets which are usually held on weekly basis.

[45] This also posed serious problems in terms of provisions for the local personnel of the Cercle, even of the most basic products such as millet (RAP.TOC.15.228).

4.6 Social organization and the livelihood system

As is clear from the foregoing discussion, both the social organization and the livelihood system underwent important changes in the course of the twentieth century. In this section the focus will be on the situation as it is found today, with some references to changes not yet dealt with above.

4.6.1 Social organization of agricultural production

As was mentioned above, the Gourmantché used to live in large compounds composed of a patrilineal extended family. At the turn of the twentieth century a village consisted of just a few of these compounds. In 1960 the average population of a village in the eastern region was still only some 340 persons, while compounds were larger than in most other parts of the country. Almost half of the compounds had more than 20 members while as much as 18% of the compounds had more than 50 members (Haute-Volta 1970: 20, 193). Today the average village size is more in the order of 600 to 800 inhabitants per village, and while the average compound size may not have decreased too much, the extremely large compounds of the past are becoming rare.

Villages generally consist of several wards (*Fr*: quartier) that can be a few hundreds of meters up to several kilometers apart. Just as each village has its chief, each ward has its chief, though this function seems to be primarily practical in nature and without the kind of status that is associated with a village chief. In addition to these wards that are inhabited year-round, there are a number of bush camps (*kuadabili*) consisting of a single, but mostly several bush compounds (*kuadiegu*) that are inhabited during the rainy season. These bush compounds are inhabited six to seven months per year. Only where dry-season water shortage is not a problem can they eventually develop into full wards and even villages. Almost everywhere in the region it is possible to borrow land for cultivation both within and outside the own village territory. Such borrowing of land outside the village territory is often facilitated by kinship ties with neighboring villages (chapter 8).

Compounds generally lie several tens of meters apart to allow crop cultivation between the compounds. A compound (*diegu*) consist of a number of huts (*dieli*) that together form more or less a circle. In-between the huts, walls made of thatched grass mats (*seko*) or large cereal stalks are placed to close the compound from the outside except for the front entrance. Compound entrances always face west because it is believed that everything evil comes from the east and should thus be prevented entry. Most huts are round and made with earth bricks (*banko*) and a thatched roof. Nowadays wealthier villagers may live in rectangular huts with a corrugated iron roof. In some parts of the region, as well as in the bush camps, the walls of the round huts are not made of earth bricks but of thatched grass mats.

Compounds consist of one or more households (Gourma: *fandiegu*; Gnagna: *dayeli*) that are usually bound together by patrilineal kinship ties. Typical configurations are a man or several brothers with his/their wives and unmarried children as well as their married male children with respective wives and children. Women leave the compound when they get married. A practice that seems to be less frequent than in the past is the lending out of children. In the past it was common practice that children were raised by a brother of their father rather than by their own father (Cartry 1966: 68). Children can also be lent out to an older widow. In some cases someone unrelated to the other compound members is first accepted as guest by the compound head and then gradually becomes part of the compound (Cartry 1966: 69).

As was outlined above, the compounds have become smaller during the course of the twentieth century and it is common for a brother or son to leave the family compound to establish one of his own. Households may consist of a man with his wives and children, but may also consist of two brothers with their wives and children, or a father with his wives and one or two sons with their wives and children.

Nowadays many aspects of agricultural production and consumption are organized at the household level rather than the compound level. While certain men in the same compound may eat the evening meal together, each man will eat the food prepared by his household. In the case of co-wives, each wife takes turns cooking for the household. Agricultural production is generally organized at the household level. Each household head has one or more principal fields, called *kuanu*, on which the major staples are grown. Such fields are usually bush fields or bush compound fields. Women and children need to join the household head for work on these fields during the main part of the day. During the early morning and late afternoon they may work on their own personal fields. These fields are usually found within the actual village or close to the bush compound if the rainy season is spent in a bush camp. In those cases where a household is composed of several brothers, or a father with his married sons, the arrangement is often such that each has one or more principal cereal fields on which their respective families work during the rainy season, rather than that everyone works on the fields of the household head. An elderly father will usually only have small fields on which various household members help out.

It is not easy for women to combine working on their own fields with their household tasks. Women of a polygamous marriage are at an advantage in that sense, because they can take turns with important household tasks such as the preparation of dinner. Children often help their mothers on the fields, and for certain tasks even husbands offer a helping hand. This occurs for instance during the harvest. Some tasks, such as land preparation are often done largely by men.

As it is the married man's responsibility to feed the family, most of his time is dedicated to the households major staple fields. If time allows, he also has a few smaller fields that he uses to grow crops such as groundnuts, Bambara groundnuts, or in some cases sweet potatoes or cassava. Also these fields are typically found within the village or close to the bush compound. In addition, married men have the responsibility to grow some quick maturing crops such as maize and red sorghum to bridge the period between the depletion of last year's stocks and the coming in of the new harvest. These crops are generally grown in front of, or close to the compound. In households consisting of a father with married sons, this is typically the responsibility of the father, while the young men do the hard labor on the large millet and sorghum fields. Such older men, with grownup children, also have much more time to dedicate to their personal fields. The same is true for older women allowing them to grow a much wider variety of crops that may also include maize or for instance cotton.

Although most of the agricultural production is organized at the household level, there are a few exceptions. The most important one, in terms of labor organization, is the use of work parties. This is a traditional practice that is still widely used today. Work parties can be called for various agricultural (e.g., clearing, harvesting) and non-agricultural activities (such as the construction of a hut). The organizer of a work party invites friends and relatives to work for a day or half a day on the field of the organizer in exchange for a meal and, often, locally brewed sorghum beer (*dolo*). This way a lot of work can get done quickly. Work parties can range from just a handful of people to 30 or more participants, sometimes even coming from other villages. Both men and women can call work parties. The parties themselves can be mixed or single-sex. Work parties are also called for the father of a bride as part of the engagement process. Work parties are discussed more extensively in chapter 8. An exception of the organization of production at the household level in terms of agricultural decision making is, that, at least in some parts of the eastern region, it was common practice that the village chief would indicate when everyone should start sowing their maize. While the maize was not grown collectively, the chief's decision was collectively followed. This practice still persists in some cases at the compound level whereby the compound head takes the initiative for sowing the maize. Maize is the first crop harvested and these practices thus probably relate to the fact that this way the whole village or compound will have new food again at the same time.

4.6.2 The organization of fields

In geographical terms, three main field types can be discerned. The compound fields immediately bordering the compound, the village fields lying in between those compounds and the bush fields or bush camp fields found at some distance from the village (see figure 4.3). This division is shared by many West African societies and for example also common among the Mossi (Vierich and Stoop 1990; Prudencio 1993). The compound fields are intensively managed and used for fertility demanding crops such as maize or for crops that

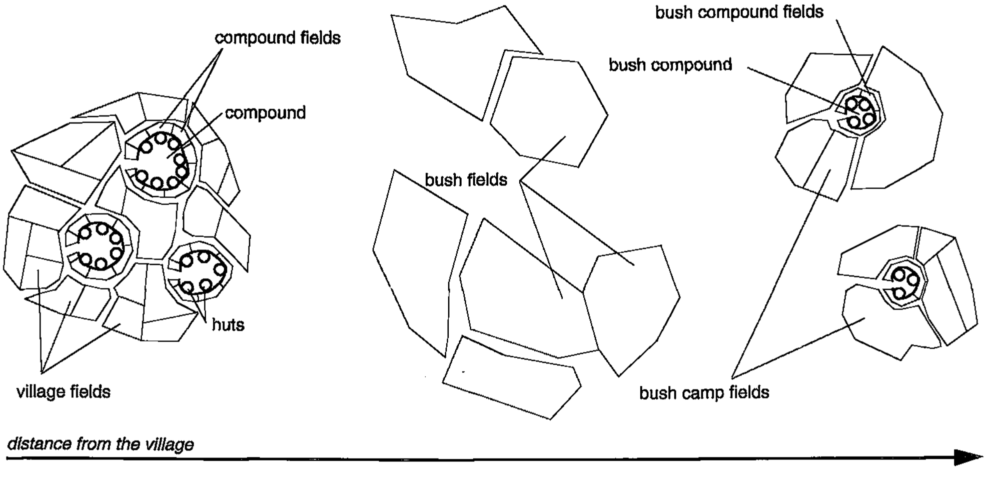

Figure 4.3. Schematic map of the spatial organization of the most important field types

one wants to have within easy reach such as okra. The compound fields may receive household refuse, crop processing residues, and manure collected from the livestock kept inside or near the compound (chapter 6). Especially the compound fields of the compound head, or in some cases of the household heads, receive a lot of organic matter as they are entitled to most of the organic matter produced inside the compound and cultivate the fertility demanding maize crop. The compound fields are cultivated on an almost continuous basis. If the compound does not move, 60 or more years of cultivation in a row are well possible. Even when the owner spends most of the rainy season in a bush camp, the compound field will generally be cultivated with the help of those staying behind. The much larger village fields are cultivated for long consecutive periods (10 to 20 years), but are managed much less intensively. They do benefit from the droppings of livestock that is kept around the village during the dry season. While in the past the security problem forced people to optimally exploit the land in the village center, many village fields have now been reverted to fallow. Their fertility has suffered from the long periods of cultivation (chapter 5) and with the increased popularity of the bush camps many of their owners are not around during the rainy season to cultivate the village fields (Wolffenbuttel 1997).

Bush fields produce the bulk of the agricultural production and are therefore too large and also too far away to manage with the same intensity as the compound or village fields. Cultivation is generally for some 5 to 10 years after which the field is reverted to fallow for 10 to 50 years. Bush fields can be located at a distance of up to 10 kilometers from the village center. Nowadays fields at such a distance are usually cultivated from within a rainy season bush compound located at the field, but in the past, when wildlife could be a serious menace for people at night, people would travel to their fields daily even at such a distance. For nearby bush fields daily travel from the village compound is the most common strategy, though with the increasing livestock densities there is a tendency towards staying close to the field, also at night, to protect the field against livestock damages. Sometimes it may be just the household head or an older son who stays overnight. Bush fields that are cultivated from a bush compound may be referred to as a bush camp field. Bush compound fields (the fields immediately surrounding the bush compound, see figure 4.3) are comparable to other bush fields in terms of their management, but as household refuse and crop processing residue are dumped on some spots in the vicinity of the compound, these spots gradually increase in fertility. While never achieving the level of fertility of the compound fields found in the village, such spots are nonetheless used to grow a little maize.

Table 4.2 summarizes the principal properties of the main field types. It is important to note that in the more densely populated areas the fallow periods for bush fields are slowly reduced, but that this is at least partially compensated for by more intensive fertility management practices. For compound fields there are no clear changes in this respect, while for village fields the fallow duration depends very much on the number of people staying in bush camps during the rainy season as they often leave their village fields fallow. The details of the management practices applied on the various field types will be discussed in chapter 6, while chapter 5 deals with the effectiveness of these practices in terms of chemical soil fertility maintenance.

The Gourmantché have various ways to refer to the variety of fields discussed above. A field can be referred to in terms of its location, in terms of who cultivates it, in terms of

Table 4.2 Principal properties of main field types

Field type	Field size (in ha)[a]	Cultivation duration	Fallow duration	Organic matter input	Soil fertility
Compound field	0.05 - 0.50	very long	none	a lot	high
Village field	0.05 - 1.00	long	long	only indirectly	low
Bush or bush camp field	0.20 - 3.50	short	long	none	medium

Source: Fieldwork.

Note: A farmer may cultivate multiple fields of a particular kind or grow multiple crops on separate plots of a single field.
[a]Field sizes are only rough indications and depend on age and gender of the farmer, as well as on the crops grown.

the time of day it is cultivated and in terms of its crop. Without a good understanding of this system it is easy to underestimate the number of plots cultivated by an individual as well as their importance (Swanson 1979a: 19). Compound and village fields are for instance not considered real fields by the Gourmantché and therefore ignored when asked how many fields an individual has. Below the various distinctions are outlined following Swanson (1979a).

The compound fields can be divided into those in front of the compound entrance cultivated by the head of the compound and called *cancanli* or *tapagili* and those cultivated by the other compound members behind their huts, referred to as *Lidapuo-loli*, *dapuona* or *dapuolikuani*, meaning "behind" or "behind plot". These names can be used irrespective of the crops grown. The village fields are called *lifeloli*, *sankagu*, *kuankuagidi* or *dayekuani*, depending mainly on the local dialect and irrespective of the crop grown. Any of these compound and especially village fields can also be referred to by combining the crop name with *loli*, the word for plot. A groundnut field thus becomes *tiin-loli* and a cotton field *kunkun-loli*. The latter terms are also used for non-sorghum/millet bush fields. A groundnut field can thus be found in the village, next a sorghum or millet bush field, or even within such a field. In all these cases it can be referred to as a *tiin-loli*. The main sorghum or millet field that falls under the responsibility of the household or nuclear family head is called *kuanu* and can consist of one or more sorghum/millet plots. The word *kuanu* is typically used for bush fields (including those at a bush camp) and generally restricted to sorghum and millet crops. Other household members may refer to this type of field as the *canba kuanu*, the field of the master, i.e., household head.[46] Sorghum and millet fields cultivated by other household members are referred to as *suali-kuanu*, meaning afternoon field. These fields are cultivated in the early morning and late afternoon. These naming conventions are in practice not always strictly applied and sometimes a field of another crop than millet or sorghum is referred to by the name of the crop and *kuanu*. This may especially happen if the field is large. Someone who cultivates mainly rice may thus refer to his rice field as *mu-kuanu* instead of *mu-loli*. According to Swanson (1979a: 23) land on which other crops than sorghum or millet are grown are only referred to as say *tiin-loli* as long as the crop is upon that land. After the harvest a *tiin-loli* ceases to be a *tiin-loli* because next year something else may be grown there. The large millet/sorghum fields retain their name *kuanu* also after

[46] In the past, when it was the compound head, the *diedano* who headed the agricultural production unit, this type of field was referred to as the *diedano kuanu* (Remy 1967: 58).

the harvest, the same is true for the rice plots, *mu-loli*, that retain their name because only rice will grow in such a location.

There is no private landownership; land is not bought or sold except in the larger centers. The first person clearing land that, as far as anyone knows, has never been cultivated by any known person or known person's ancestors gains ownership-rights to that piece of land for himself and all his descendants. Such claims hold whether the land is cultivated or fallowed. Land may be, and is often, lent out to kin or non-kin. In such cases the borrower may generally cultivate it for an indefinite amount of time until it is put to fallow again and the use rights are lost. Planting trees requires the consent of the landowner because it extends the use rights beyond the normal cultivation period. Ownership of land is seen as separate from the ownership of the standing crop on this land. Traditionally, in most parts of the eastern region, only the fruits of the locust tree belong to the owner of the land whereas the fruits of other non-cultivated trees were not considered the exclusive property of the landholders (Swanson 1979a).

4.6.3 The crops

The most important crops in the eastern region are millet (*Pennisetum glaucum*), sorghum (white and red; *Sorghum bicolor*), maize (*Zea maïs*), groundnuts (*Arachis hypogea*), cowpea (*Vigna unguiculata*) and sesame (*Sesame indicum*). As can be seen in table 4.3, 80 to 90% of the cultivated area is covered by cereals in Gnagna and Gourma province respectively. In Gnagna white sorghum is the most popular cereal, whereas it is millet in Gourma. Red sorghum, used for making dolo (local beer) and, just as maize, as a crop to bridge the time between when last year's harvest has been consumed and the new one is not yet in, is more popular in Gourma then in Gnagna. It is mainly grown by older men. Sorghum and millet are frequently intercropped. Maize covers a small area and is typically grown on the best organically fertilized soils around the compound.

Groundnuts are very popular for cash generation (especially among women and

Table 4.3 Major crops grown in the eastern region as a percentage of total cultivated area (1993-1996 average)

Province	Intercropping[a]	Millet (%)	Sorghum white (%)	Sorghum red (%)	Maize (%)	Groundnuts (%)	Cowpea (%)	Sesame (%)
Gnagna	primary crop	29	45	3	2	20	0	0
	intercrop	*15*	*5*	*<1*	*<1*	*<1*	*24*	*3*
Gourma	Primary crop	41	35	10	4	7	<1	0
	intercrop	*6*	*6*	*3*	*<1*	*<1*	*46*	*<1*

Sources: MARA (1995b, 1996a, 1996b, 1997b).

Note: Only crops that cover more than 1% of the total area in at least one of the two provinces were included in the table. The relative area covered by different crops varies from year to year. Relative differences of 30 to 40% are typical. To some degree this may be a problem with the agricultural statistics, but it is definitely also a reflection of farmers adjusting the crop mixture at sowing time depending on how much rainfall they expect.

[a]Most crops are grown as intercrops: primary crop stand for sole crop or primary crop, while intercrop stands for a secondary crop.

children) and have significantly grown in popularity since colonial times (see also chapter 7). In Gnagna they cover as much as 20% of the cultivated area, generating some 10% of the national production. Cowpeas are typically grown as an intercrop on millet and sorghum fields, pure cowpea fields are extremely rare. Sesame is also a typical intercrop, primarily grown in conjunction with groundnuts, but also occasionally with millet or sorghum. It is often sown in lines inside or bordering a field.

Minor crops, not displayed in table 4.3, are rice (*Oryza glaberrima, Oryza sativa*), Bambara groundnuts (*Vigna subterranea*), yams (*Dioscorea spp.*), sweet potatoes (*Ipomea batatas*), cassava (*Manihot esculenta*), cotton (*Gossypium spp.*) and soya (*Glycine max*). Rice is typically grown in the bottomlands and covers around 1% of the cultivated area. Bambara groundnuts are grown pure or intercropped with groundnuts and cover less than 0.5% of the cultivated area. Yams, sweet potatoes, and cassava are typically found on just a few fields in a village, mostly cultivated by married men. Towards the south they are slightly more popular. Cotton is nowadays hardly grown at all in Gnagna, while it covers around 0.5% of the cultivated area in Gourma province. The most recent promotion of cotton in 1995 has had little effect (section 4.5.2), only in Tapoa province it now covers around 4% of the cultivated area. Soya is mainly grown by married women in Gourma province covering around 0.5% of the cultivated area. Finally there are a number of traditional crops that do not show up in the national statistics. These are tobacco (*Nicotiana spp.*), okra (*Hibiscus esculentus*), rosella (*Hibiscus sabdariffa*), kenaf (*Hibiscus cannabinus*), chili peppers (*Capsicum frutescens*) and a local eggplant landrace (*Solanum melongena*). Tobacco is grown by some older men and transplanted onto their maize field just before the maize harvest. Okra and rosella are only grown by married women, whereas kenaf, a fiber plant, is grown by men as a border around any field. Chili peppers and eggplant are grown on a small scale by a few men. In recent years, a few men have started small, dry-season gardens to grow hand-irrigated vegetables for sale on the markets. These vegetables include eggplant, potatoes, tomatoes, onions, and cabbage.

Tree crops also traditionally play an important role in the farming system. Most trees are not planted but found in the bush, or retained on the field when it is cleared for cultivation. Recently, people have started planting mango, guava and papaya trees. Especially mango trees are very popular and are now found throughout the region, inside and in the vicinity of the villages. They were introduced by the French but became popular in the last 20 to 30 years. Sometimes they are grown together in orchards. Other important trees are the shea tree, the locust tree, and the baobab. The fruits of the shea tree are used to make cooking fat and soap, the fruits of the locust tree are one of the ingredients for *soumbala*, which is used for seasoning in sauces. The leaves of the Baobab tree are a popular sauce ingredient. There are numerous other, less well known, trees and shrubs whose fruits or leaves are used for consumption.

4.6.4 The yearly agricultural calendar

The yearly agricultural cycle consists of five or six phases: clearing (only for a new field), land preparation, sowing, weeding, harvesting, and storing/processing. Figure 4.4 depicts the yearly agricultural cycle graphically against the backdrop of the long-term average monthly rainfall distribution in Fada N'Gourma.

Clearing of a new field takes place before the rainy season, sometimes as early as February or March. On the location of the new field, shrubs and certain trees are cut. Other trees are left intact because of their utility for medicinal purposes or because they produce edible fruits or leaves. Trees that are retained include, but are not restricted to, the shea tree, the locust tree, and the baobab. The branches and trunks of the bushes and trees that are cut down are burned in heaps on the new field. Clearing of new land is typically done by men, often through a work party.

Land preparation takes place in May and June. Annual resprouts of bushes are cut and the branches are burned in situ or sometimes left to decay on the spot. Last year's crop residue (stalks) may be burned in piles or left on the field if it will not hamper cultivation. According to MARA (1996a: table A104) about half of the plots in Gnagna and Gourma provinces receive no tillage prior to sowing, about one-third of the plots are hand-tilled using a hoe, while around one-fifth is tilled with a plow.

Sowing takes place between May and July depending on the rains. Sowing is done with the aid of a hoe and a calabash containing the seeds. Generally multiple seeds are dropped in each planting hole. Where sorghum and millet are intercropped they are sown at the same time by mixing the seeds in the required proportion in the calabash.

Weeding is generally done in two to three rounds depending on the available labor and the size of the field. Large fields of sorghum or millet are often weeded only twice (by merging the first and second weeding). The first weeding takes place when the plants are still very small and takes relatively little time. The second weeding is done before the plants reach some 50 cm and takes a lot of work. Thinning and transplanting to fill gaps takes place during the first and second weeding round. A third weeding takes place around florescence. Weeding is generally done with the aid of a hoe.

Harvesting takes place between September and January. Maize and red sorghum are the first crops to be harvested around September. Millet and white sorghum are harvested between October and January depending on the landraces, rainfall and the soils. The peak generally falls in November-December. Harvesting of cowpeas usually begins before that

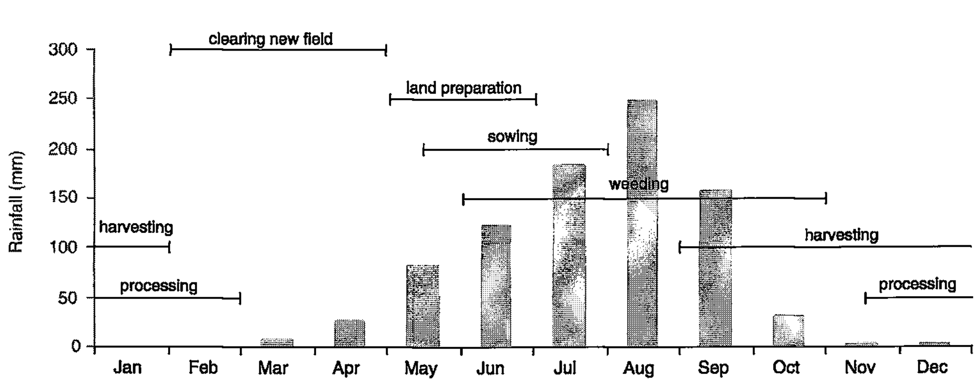

Figure 4.4. The yearly agricultural calendar

Source: Rainfall data from national meteorological service of sorghum and millet, but it can be interrupted in order to harvest the grain crops in time and then be resumed once the grain harvest is over. Groundnuts are mostly harvested between November and January. An early harvest of groundnuts is easier because the soil is still a little moist. Some crops are harvested on a piecemeal basis, such as okra and often the first part of the maize harvest. In the case of sorghum and millet the stalks are first cut slightly above the soil, usually by men. During the next round women cut the heads and deposit them near the field. Some crops have a so-called second harvest whereby after the field has been harvested women and children go through the field looking for remaining heads. What they collect during the second harvest is for their proper use. Also groundnut has a second harvest, but this generally takes place with the first rains of the next season (somewhere between March and May), and the groundnuts are used for direct consumption or as a sauce ingredient.

The final phase in the yearly cycle is the processing and storing of the harvest. Based on the quantity produced, old granaries are repaired and new ones are constructed. The main granaries are kept on or next to the field and are constructed with thatched grass mats (*seko*). The larger part of the harvest is stored in the form of heads in these granaries. From time to time some basketfuls are taken out of the granaries to be threshed in situ and transported to the compound in the form of grain. As granaries can be at considerable distances from the compound, for instance when they are located at a bush camp, they are protected with magic against theft. Until now thefts are indeed rare as the magical powers of the Gourmantché are well respected, also among other ethnicities. Protection through magic is also an effective strategy to control the access of family members to the granaries, because it is generally the family head who protects the granaries and needs to temporarily lift the spell to allow women to take out the grain.

Apart from a yearly agricultural cycle there is also a multi-year cycle or crop rotation pattern that will be dealt with in chapter 6, as it is a vital component in the fertility maintenance strategy of farmers.

4.6.5 Livestock

At the turn of the twentieth century cattle was primarily owned by the Fulbe minority and the village chiefs. According to Poiret (RAP.MON.03) only in the region of Komin-Yanga and Sanambaoré did a larger part of the sedentary population (mainly Yaama) have cattle which were guarded by the Fulbe. Poiret also reports on the losses incurred by the local population due to German confiscations, the colonization war with Bantchandé, and finally, the first tax of 1899. In all, he estimates that some 3000 heads left the region. Vermeersch (RAP.DIV.97), in his version of the conquest, reports that many chiefs offered cattle to the French mission to show their submission. This all suggests that considerable amounts of cattle were held by the Gourmantché at the eve of the French colonization. From a livestock census that was held in 1910, at the same time as the population census, it can be deduced that from a total cattle population of 57 thousand animals as much as 28% belonged to the Gourmantché and Mossi (RAP.POL.10). Based on oral sources it is likely that the larger part of these 28% was owned by Mossi, as they are said to "have gotten into animals" much earlier than the Gourmantché.

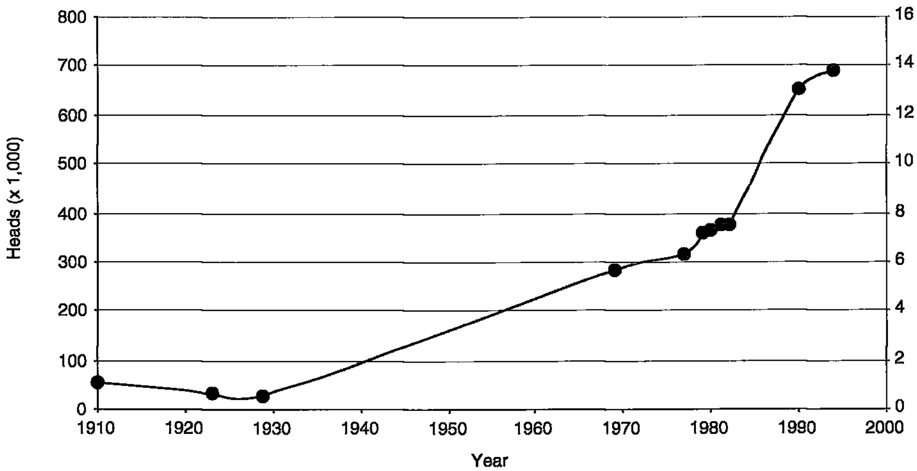

Figure 4.5. Cattle population in Burkina Faso's eastern region (1923-1994)
Source: Table B.3 in appendix B.

Apart from cattle, important numbers of sheep, goats, horses, donkeys, and poultry were kept (RAP.MON.03; RAP.INS.24).[47] The importance of livestock was only to grow during the course of the twentieth century. What drastically decreased, however, were the number of horses in the region. Between the early 1920s and the early 1990s the number of horses in the eastern region went down from an estimated 7000 to 2500, while the human population grew from 190,000 to over 800,000 persons. In pre-colonial times horses offered prestige and had been important in warfare for the cavalry and as a general means of transport. As warfare came to an end with the French occupation and bicycles and mopeds have now become widespread there is little need for horses and generally speaking only the most important chiefs keep them for ceremonial occasions.[48]

While livestock estimates, especially of the smaller animals, are surrounded by even more uncertainties (as a full count is practically impossible) than those of the human population, there has undoubtedly been a strong growth in the course of the twentieth century. As can be seen in figure 4.5 the cattle population in the eastern region is at present more than 20 times higher than in the 1920s, raising the density from less than 1 head km^{-2} in 1923 to around 14 heads in 1994. The number of heads per capita grew from 0.15 in the 1920s to some 0.7 to 0.9 for the period between 1969 and 1994, suggesting that the major increase in cattle ownership took place before 1970. Apart from horses, all other types of livestock have seen growth similar to that of cattle. Today, the size of the cattle and sheep population are close to the human population, while the number of goats has surpassed the human population according to the 1994 statistics (MARA 1995a).

Livestock is not spread equally over the region. Gnagna province has the highest livestock densities, followed by Gourma province, while Tapoa has the smallest livestock

[47] Probably people, especially in the southern part of the region, also kept rabbits already at that time. Pigs were probably introduced around 1910 by the French (RAP.POL.10).
[48] There is also a good chance that the tax on horses speeded their decline in numbers.

population. Table 4.4 lists the livestock figures for Gnagna and Gourma provinces. The differences in cattle densities correspond more or less with those of population density, with a three times higher density in Gnagna than in Gourma province. Covering only 3% of the surface of Burkina Faso, Gnagna has 6% of the national cattle population. This unequal distribution of livestock over the area goes back to pre-colonial times and is related to the historical Tsé-tsé problem in the southern part of the region (RAP.POL.10).

Nowadays cattle ownership is no longer limited to the Fulbe, the village chiefs, and wealthy individuals. A growing number of farmers has one or two heads of cattle, while quite a number now even have a small herd. According to the 1993 national agricultural survey (MARA 1996a: tables A124 to A130) women now own almost 8% of the cattle. For sheep this is around 20% and for goats around 30%. In Gnagna the proportion is always slightly higher than in Gourma. Pigs are, with almost 60%, mostly a women's affair. As in the past, Gourmantché cattle is often kept with the Fulbe, primarily because herding is their profession and also to hide wealth from the eyes of other villagers. Parallel to the growing numbers of Gourmantché owning cattle, the number of animals owned by the Fulbe has decreased. An increasing number of Fulbe have no, or almost no, animals of their own in the herd they take care of. Having sold large numbers of animals to the Gourmantché during the recent droughts of 1972-73 and 1984-85, they find themselves increasingly dependent on Gourmantché owned cattle. Another trend is that a growing number of Gourmantché keep some cattle around the compound for livestock fattening and to have better access to manure. The importance of livestock in the Gourmantché farming system and the associated Gourmantché-Fulbe relations are further dealt with in chapter 8.

4.6.6 Other economic activities

As was outlined earlier, the eastern region has remained a neglected region for much of the twentieth century. The 1960-61 demographic survey (Haute-Volta 1970) reported the second lowest literacy rates of the country for the Gourmantché (0.9% for men) and the

Table 4.4 Livestock numbers and density in Gnagna and Gourma provinces in 1994

Animal	Gnagna		Gourma	
	Number of animals (heads)	Density (heads km^{-2})	Number of animals (heads)	Density (heads km^{-2})
Cattle	265,000	30.8	294,900	11.1
Sheep	241,200	28.0	289,800	10.9
Goats	426,400	49.6	367,300	13.8
Pigs	3,400	0.4	17,900	0.7
Donkeys	11,000	1.3	17,500	0.7
Horses	808	0.1	1,010	0.0
Poultry	693,500	80.6	682,300	25.6
TLU[a]	*289,048*	*33.6*	*320,220*	*12.0*

Source: MARA (1995a).

[a]TLU stands for Tropical Livestock Unit and is calculated as follows: 1 dromedary = 1.1 TLU, 1 horse = 1 TLU, 1 Donkey or Cow = 0.8 TLU, 1 pig = 0.2 TLU, 1 sheep or goat = 0.1 TLU (Williamson and Payne 1978).

third lowest level of French speaking (2.9% for men). According to the 1991 demographic survey (INSD 1994) today still only 3% of the rural population of Gnagna and Gourma provinces, aged 10 and older, is alphabetized in French (of which three quarter were men) and 95% is not alphabetized in any language at all (the national rural average is 91%). In terms of formal education the situation is even worse with only 3% of the rural population of the research area, aged 10 and older, having any schooling at all (compared with a rural average 9% for the country). In more than 80% of the cases this consists only of primary education. There are few differences in this sense between Gnagna and Gourma provinces (INSD 1994).

The low level of instruction combined with an "off the road" location has meant that there are few economic activities of importance outside agriculture and the trade of agricultural produce (including livestock). Most general trade is in hands of Dioula and Hausa traders that come from outside the area, and, in addition, Fada N'Gourma has some important entrepreneurs of Syrian origin. The majority of the population, however concentrates on marketing agricultural surplus production at the local markets where it is often bought by larger traders who take it to the major centers inside and especially outside the region. Production for the market is not new and already in the late seventies Swanson (1979a: 21) noted the importance of the marketing of surplus grain production as well as crops such as groundnuts and sesame that are grown primarily for the market. With the recent establishment of the Kompienga lake (for electrical power generation, see map 2), with a downstream irrigation scheme, as well as small irrigation schemes at other locations in the eastern region, the number of pure cash croppers (cultivating crops such as potatoes, cabbage, onions, and watermelons) has increased in recent years, but this still remains a small minority.

In addition to the selling of agricultural produce, petty trade also forms an important source of livelihood, especially for women, who collect and process bush products, prepare foods and brew beer for selling inside the village and at local markets (plates I and II). Both women and men also sell tobacco and kola nuts. Men additionally tailor, weave, engage in commerce, and transport goods with carts in exchange for money (plate III). More details on off-farm activities are given in chapter 7.

While mineral resources are few in the region, some rock phosphate is found and processed in Tapoa province and in the area around Bilanga there is some gold mining, mainly in the hands of foreign companies. Some local farmers earn extra money with gold digging during the dry season.

4.7 Development interventions

4.7.1 State interventions

While a large number of NGOs and international development agencies are active in Burkina Faso, the eastern region has until recently received very little interest from their side. From the colonial period until the 1980s state development interventions are therefore a major factor. Interventions range from education to water supply to agriculture. Our focus here will be on those in the agricultural domain.

Initially agricultural development was the responsibility of the Commandant de Cercle. It was not until 1922 that an agricultural officer and two assistants were added to the national administration, while it took until 1944 for separate departments for agriculture, livestock and forestry to be created (Lankoandé 1991). Because of a lack of dedicated personnel, agricultural interventions by the colonial administration until the late 1940s focussed mainly on price, tax and marketing policies, while technical interventions were largely limited to the introduction of new crops (such as fruit trees, onions, and other vegetable crops) and the promotion, sometimes through coercion, of certain cash crops (e.g., groundnuts, cotton) and later also food crops such as cassava (Madiéga 1996).

More systematic technical interventions geared towards the "modernization" of the African agricultural practices were not adopted until 1947 when the first 5-year FIDES plan (Fonds d'Investissement pour les Dépenses d'Intérêt Économique et Social) took off. As part of this plan several agricultural centers (Centres de Cultures) were created to train farmers in plowing with animal traction. By 1954, 29 such centers had been created in the country, among which several in the eastern region (Lankoandé 1991). These centers were managed by the Sociétés Indigènes de Prévoyance (SIP). The SIP were initiated in 1910 to administer reserve grain stocks and seeds, and to lend out and sell agricultural equipment. In the Cercle de Fada the SIP was not created until 1934 (Lankoandé 1991; MARA 1997a). In 1954, farmers bought 12 plows and ordered another 22 in the agricultural centers in the eastern region. It was also in 1954 that the SIP financed animal traction equipment for two pilot villages in the Cercle de Fada (Lankoandé 1991). In 1956 the SIP were transformed to Sociétés Mutuelle de Protection Rurale (SMPR)[49] and subsequently in 1960 into Collectivités Rurales (CR) that basically retained the same function (interview with former regional director of the extension service Bernard Lompo,[50] MARA (1997a), and Madiéga (1996)).

The main focus during the second 5-year FIDES plan (1953-1957) was the introduction of a number of pilot farms (fermes pilotes) throughout the country. Selected farmers were offered the opportunity to start a pilot farm for which they were offered a pair of oxen, a plow, a harrow, a mower, and a cart (MARA 1997a). As Bernard Lompo, who in 1958 became the first African director of the agricultural sector of Fada,[51] explained: stables were constructed for the oxen and instructions were given on the rotation to be followed, the use of the plow, sowing in rows, the application of manure, and how to do green manuring. At the time there were at least 55 pilot farms in the region, mainly around Diabo, Tibga and Matiakoali (see map 2). According to various sources (Madiéga 1996; MARA 1997a) the pilot farms were not a success for several reasons: participants had mainly been selected according to political motives, yields were not much higher than under traditional practices, there were insufficient well-trained extension agents to support the farmers technically, and less than 500 of the envisioned 800-1000 pilot farms were actually created. Around 1960 the pilot farms were abandoned (MARA 1997a).

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[49] According to Asche (1994) the acronym SMPR referred to Sociétés Mutuelle pour la Production Rurale.

[50] Interview on 11 April 1997, Fada N'Gourma.

[51] At the time the country was divided into 6 agricultural sectors of which Fada was the second. This agricultural sector covered the Cercle de Fada, but also Tenkodogo, Garango and Dori (interview with Bernard Lompo).

Starting in the 1950s the agricultural service created demonstration plots (parcelles de démonstration) in the villages to demonstrate sowing in rows and the effects of mineral fertilizer, manure, and pesticides on crop production. A volunteer farmer was asked to cultivate this demonstration plot. Starting in 1963 the system changed slightly in that village associations (groupements) were formed that collectively cultivated a demonstration plot (interviews with Bernard Lompo and veteran extension agent Jules Tandamba[52]).

Starting in the 1960s the state developed a dual extension system that combined a system of agricultural education of the youth in rural schools with a regular extension system of agents visiting villages and extending new technologies and practices (Asche 1994). The system of rural education was effective under various guises and ministries between 1961 and 1992. The idea was that children in the age of 13 to 14 years would get a number of years of schooling in French and modern agricultural practices at so called écoles rurales located throughout the country (interview with Jules Tandamba; MARA 1997a). Originally as many as 2000 of such rural schools were envisioned within 10 years, but by 1990 only 640 of these schools existed (Asche 1994; MARA 1997a).[53] The schools did not bring about the envisioned success because the school-leavers were too young (aged 17 years) to significantly influence the agricultural practices of the family farm, and having learned some French, many left towards the larger towns and cities inside and outside the country (MARA 1997a).

In the early 1960s the agricultural sectors responsible for extension services were changed to agricultural regions and beginning in 1966 these were transformed into so called Organismes Régional de Développement (ORD). The eastern ORD that covered the whole eastern region was formed in 1969 and lasted until 1988 when all the ORDs were transformed into Centres Régional de Promotion Agropastorale (CRPA) (interviews with Jules Tandamba and Bernard Lompo; MARA 1997a; Gaanderse 1998). This change was an attempt to overcome several problems with the ORDs including the poor management of human and material resources, the insufficient technical level of the agents, and the lack of impact on the farmers and the national production (Asche 1994). Unlike the ORD that had had a wide range of development tasks including the commercialization of agricultural products, the CRPA could focus more on the extension of agricultural knowledge and technology (MARA 1997a; Gaanderse 1998). The CRPA continued to work with a system of extension agents that assisted village associations in the use of modern agricultural technologies on collectively cultivated fields. With interested individuals they also set up demonstration plots. Because each agent was responsible for six to eight villages it was not possible to cover all villages in the region. In a 1993 agricultural survey (MARA 1996a: table A45) less than 30% of the heads of households in the eastern region reported having received agricultural extension compared to a national average of 36%.[54] In 1997 the CRPA was transformed into Direction Régionale de l'Agriculture et des Ressources Animales (DRARA) as part of a reform that led to a further reduction of tasks and personnel (interviews with Jules Tandamba and Bernard Lompo; MARA 1997a; Gaanderse 1998).

[52] Interview on 16 March 1997, Fada N'Gourma.

[53] The écoles rurales were renamed in 1974 to Centres de Formation des Jeunes Agriculteurs.

[54] In almost 90% of the cases where extension was received in the eastern region, it was carried out by the CRPA.

Up until the early 1980s, the state agricultural interventions focussed strongly on the introduction of plowing with animal traction and to a lesser degree on improved varieties, the use of inputs such as pesticides and mineral fertilizer, sowing in rows, the protection of the harvest through insecticides, and rural credit. During the colonial and early post-colonial period animal traction focussed on oxen, and it was not until the 1970s that the cheaper, donkey-drawn plows were promoted (Boele 1998). As is clear from a recent national agricultural survey (MARA 1996a) the effect of these efforts has been limited: Less than 20% of the households in the eastern region own one or more plows (the national average is almost 30%), just over 5% owns one or more oxen while another 15% owns one or more donkeys, only 5% of the plots is sown in rows (the national average is 20%), and in Gnagna and Gourma less than 0.2 kg of NPK are used per cultivated hectare (the national average is 7.5 kg ha^{-1}).

Starting in the 1980s, soil and water conservation and environmental protection have become important points of attention of the ORD/CRPA as well as the Ministry of Environment and Tourism and a number of NGOs (Boele 1998). In 1979 the eastern ORD became involved in the second phase of a large-scale anti-erosive effort financed by the Fonds de Développement Rural (FDR) that had until then focussed mostly on the Central Plateau. In the 1979/80 season 135 ha of the eastern ORD were covered by earth bunds. Tractors were used for the heaviest work, while villagers were paid with food-for-work to construct the actual bunds with hand tools supplied by the FDR (Reij 1983). The anti-erosion measures were not a success because they were not maintained by the local population. There was no food-for-work program for this purpose and only few farmers benefited from the bunds (Reij 1983; Marchal 1986). During later years attention of the ORD/CRPA became more focussed on demonstrating the utility of stone bunds (cordons pierreux) and reforestation (Boele 1998). Despite the fact that the ORD/CRPA was supported in this effort by local NGOs such as the APRG (section 4.7.2), who supplied the population with equipment such as wheelbarrows and pick-axes, still only 3% of the plots in the region were recorded as having anti-erosive measures in the 1993 agricultural survey (MARA 1996a: table A98), compared to a national average of 10%.

In recent years the Direction Régional de l'Environnement et du Tourisme (DRET) later renamed to Direction Régional de l'Environnement et des Eaux et Forêts (DREEF) has taken on an important role in environmental conservation at the village level. In earlier years, the Ministry of Environment and Tourism had concentrated on the protection of the national parks and reserves, the fight against poaching, the management of hunting tourism, and the campaign against bush fires. Starting in the 1970s this was augmented by several (re-)forestation programs such as the Swiss funded "Bois de Village" in 1978, the 1985 "Programme National de Foresterie villageoise" (PNFV) and the 1994 project "8000 villages 8000 forêts" (Boele 1998; Gaanderse 1998). None of these was a success as there were problems with the availability of seedlings and there was no follow-up after the initial efforts (Gaanderse 1998). Currently, environmental activities of the DREEF include the maintenance of tree nurseries, the vegetative protection of anti-erosion measures, the planting of wind-breaks and the promotion of agro-forestry practices (Boele 1998; Gaanderse 1998).

4.7.2 *Non-governmental interventions*

Until well into the 1970s church organizations remained the most important non-governmental agencies active in the eastern region. Both the first protestant mission and the first catholic mission date from 1936 (RAP.POL.65c). By 1956 the protestant mission, which was part of the US-Canadian founded Sudan Interior Mission, had expanded from Fada N'Gourma to several other locations: Diapaga and Maadaga in the east, Pama in the south, Piéla in the north, and Niendouga close to Fada (RAP.POL.56c). Even so, they seemed to have had very little impact until at least the late 1950s. There were few converts and the subsequent Commandants de Cercle continued to wonder in their annual reports what the American and Canadian pastors "who spoke better Gourmantchema than French" were up to (RAP.POL.47c; RAP.POL.52c; RAP.POL.56c). For the catholic mission Diabo was the most important base, while by 1956 there were posts in Fada N'Gourma, Mani in the north, Kantchari and Diapaga in the east and Pama in the south (RAP.POL.52c; RAP.POL.56c). While by the mid 1950s the catholic mission ran several schools and by the mid 1960s also an orphanage and several dispensaries, the protestant mission had no dispensaries and no schools, except for a small bible school at Niendouga to train catechists (RAP.POL.56c; RAP.POL.65c). Of particular importance for the agricultural developments in the villages around Fada N'Gourma was Maurice Cola, a French volunteer associated with the catholic mission, who in the mid 1960s introduced vegetable crops and plowing with animals traction to the villagers (interviews with Jules Tandamba and villagers in Pentouangou; see also chapter 8). Today, both the catholic and the protestant missions are active in development activities ranging from literacy to health services. Often Bible instruction is combined with development activities.

From the mid 1970s until the early 1980s various United States based organizations were active in the region, ranging from the Peace Corps to Michigan State University (MSU). The MSU program was concerned with animal traction and was carried out in cooperation with the regional extension service (ORD). This USAID-funded program, provided the regional agricultural service with equipment and other facilities (such as buildings), many of which are still used today. It was also during this time (1978) that the APP (Association Pour la Productivité), renamed to APRG in 1988 (Association d'Appui et de Promotion Rurale du Gulmu) was founded with USAID funding (Boele 1998). Currently the APRG is one of the most important NGOs active in Gnagna and Gourma provinces, focussing on agriculture, soil and water conservation, and credits. It is locally managed and receives funding from various international donors. With the coming to power of Sankara in 1983, the US involvement with the area came to an end.

The drought of the mid 1980s attracted the attention of a number of NGOs that had not been active in the area before, such as the OXFAM financed project Paf/Thion (Projet Agro-forestier de Thion) that started in 1987 in Gnagna, Voisin Mondiaux that began their work in Gnagna in 1987 and the AEEBF (Association des Églises Évangélique du Burkina Faso) that settled in the area in 1984 (Boele 1998; Gaanderse 1998). The focus of these organizations is on agriculture, soil and water conservation and the environment, while their presence is largely restricted to the northern part of the drier Gnagna province. Apart from some PDR (Projet de Développement Rural) projects active in Tapoa province the majority of the NGOs active in the southern part of the eastern region (Gourma and Tapoa provinces and southern Gnagna) are local ones that receive external funding but are native to the area. The APRG was already mentioned. Other ones are the alphabetization organization ATT (Association Tin Tua) that started in 1989 and has its roots with the PAG (Programme d'Alphabétisation au Gulmu) that was initiated in 1985-1986 (Boele 1998), and the recently created ARFA (Association pour la Recherche et la Formation en Agro-ecologie) active in (ecological) agriculture.

4.8 The research villages

After a thorough selection procedure, in which almost 30 village were visited in various parts of Gourma and Gnagna provinces, two villages were finally maintained for detailed research, while three others were studied in less detail (chapter 3). The three secondary villages were mostly used as a frame of reference to distinguish general patterns from distinct characteristics of the study villages and to enhance the representativeness of this study. All of the selected villages are representative for the region in terms of their size and population mix. At the same time there are important differences between villages. Each village has its own particularities caused by the particular history of the village, the presence of a school, lack of rainy season access by road, proximity to a permanent river, the character of a chief, etc. By studying more than one village it was possible to get an idea of those village characteristics that are common to all villages in the region as well as those that tend to vary from village to village. This section will begin by briefly introducing the main and secondary research villages, followed by a presentation and comparative discussion of the two main research village from which most of the data in this study are derived (see chapter 3).

The two main research villages are Samboanli in Gnagna province and Pentouangou in Gourma province (see map 2). Samboanli, located in Bilanga department, is some 90 kilometers NW of Fada N'Gourma and accessible by dirt road. It had 656 inhabitants in 1996, living in four Gourmantché wards, one Rimaïbè/Mossi ward and one Fulbe ward. Pentouangou, located in Fada department, is some 15 km SSE of Fada N'Gourma and accessible by motorable track. It had 722 inhabitants in 1996, living in three Gourmantché and three Fulbe wards. Both villages are at least a century old and have no current development intervention, although Pentouangou was officially part of the network of villages that should receive regular visits from an extension agent.

Of the secondary villages Tiambargou is located in Gnagna and Binadeni and Kpendema are located in Gourma province (see map 3). Tiambargou had some 200 inhabitants in 1985 (INSD 1989) and is located in Bilanga department. There are only cart trails providing access to the village. It is surrounded by laterite hills and consists of two Gourmantché wards. The village is at least 100 years old. Since 10 years some Fulbe have settled on the village territory. There is no current development intervention. Both Binadeni and Kpendema in Gourma province are located in Fada department. Binadeni is located at a distance of 15 km from Fada by motorable track. The village, is at least 100 years old and has some 300 to 400 Gourmantché inhabitants living in a single ward. Fulbe are living on the fringes of the village territory. Officially the village is part of the extension network.

This village was the topic of an MA thesis by Wolffenbuttel (1997). Kpendema, instead, is a recently established village dating from around 1985. It had some 1000 inhabitants in 1995 (own census) but continues to grow as more immigrants from the north of Gourma and Gnagna province continue to settle. It has eight wards that are up to several kilometers apart. The village was established some 50 km from Fada N'Gourma in a very sparsely populated area that until recently was used mainly as a livestock transhumance corridor to Togo. It is at a distance of some 15 km from the tarmac road between Fada and Pama and only accessible by motorable track during the dry season. Some wards are not accessible by car at all. Also this village is officially part of the extension network.

4.8.1 The main research villages and their differences

Main characteristics

Table 4.5 gives selected characteristics of the two main research villages. There are three striking differences between the two villages. Samboanli, the northern village, has a considerably lower annual rainfall level than Pentouangou, the southern village. The second major difference is, that despite the comparable total population, the village territory of

Table 4.5 Selected characteristics of the main research villages

	Samboanli	Pentouangou
Coordinates	12°30' N, 0°04' W	11°55' N, 0°25' E
Annual rainfall (1970-94)	650 mm	800 mm
Size of village territory	13 km^2	56 km^2
Proportion of village territory under cultivation (1996)[a]	20%	5%
Proportion of village territory used for agriculture[b]	65% (in 1994)	14% (in 1987)
Estimated population density (1996)	50 inh. km^{-2}	13 inh. km^{-2}
Wards	4 Gourmantché; 1 Rimaïbè/Mossi; 1 Fulbe	3 Gourmantché; 3 Fulbe
	Population (1996)	
Gourmantché	418	410
Fulbe	71	312
Rimaïbè	52	-
Mossi	115	-
Total	*656*	*722*

Sources: Rainfall figures national meteorological service; population figures based on own 1996 village census (chapter 3); size of village territory based on aerial photo interpretation; proportion cultivated based on population density and provincial averages for cultivated area per capita derived from MARA (1996a); proportion used for agriculture based on aerial photo interpretation.

[a]This is the area cropped in a single year and excludes short-term fallows.

[b]This includes cultivated land and fallows. It excludes pastures and long-term fallows that have regenerated to "natural" savanna. Areas were determined based on aerial photo interpretation. The year between brackets indicates the year for which the photographs were available.

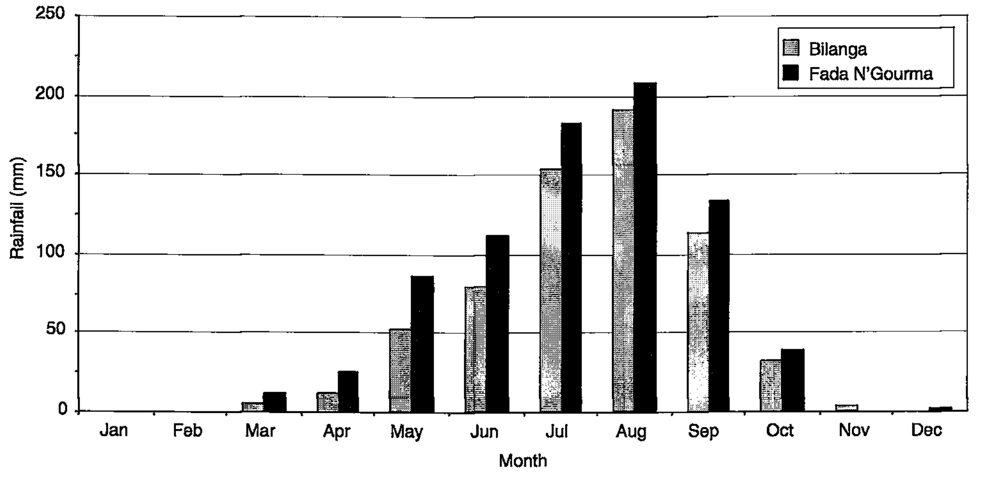

Figure 4.6. Rainfall distribution at Bilanga and Fada N'Gourma stations (average for 1970 to 1998)
Source: National meteorological service and ADDS (1998c).

Samboanli is only one fourth the size of that of Pentouangou, leading to an almost fourfold population density and a much larger proportion of area that is cultivated in a single year. The difference between the villages is even more pronounced if one looks at the proportion of village territory that is used for cultivation (i.e., including fallow land that has not yet regenerated to "natural" savanna). In that case, Samboanli appears to be almost saturated with over 65% of its territory being used for cultivation. The third major difference is that Samboanli is ethnically more diverse than Pentouangou, the latter having only Gourmantché and Fulbe inhabitants.[55]

Natural environment

In terms of the average annual rainfall, Samboanli receives some 150 mm or 20% less rainfall than Pentouangou. As can be seen in figure 4.6 the rainy season starts only a little earlier at the Fada N'Gourma station (15 km from Pentouangou) than at the Bilanga station (5 km from Samboanli) but most of the monthly totals are lower for the Bilanga station. This leads to an effective rainy season (sowing to harvest) that is comparable in length, but on average significantly wetter in Pentouangou than in Samboanli.

Because of the higher rainfall and the much lower population density, Pentouangou has a more lush vegetation. Shrubs, trees, and grassland still cover the vast majority of the territory, while the larger part of the Samboanli territory is covered by fields and fallows. Samboanli, therefore, has more of a park landscape with trees surrounded by fields and small shrubs. In Samboanli dense woodland is restricted to sacred sites. The territory of Pentouangou consist of a large pediplain with just a few granite outcrops and laterite hills

[55] During the last field visit we were told that quite a number of Mossi families have settled recently somewhere in the bush of the Pentouangou village territory. As we had never come across them or heard about their existence we have not been able to verify this information ourselves.

and bordered by large valley-bottoms towards the south and east. Samboanli is much more hilly with many laterite hills and a few granite outcrops. It is bordered on the south by a large valley that has however been permanently flooded when a water retention dam was build in 1963 at Bilanga to create an artificial lake. Both village territories have a variety of soil types though the soils in Samboanli tend to be more gravelly then those in Pentouangou.

Ethnic composition

The ethnic heterogeneity of Samboanli is typical of the ethnically mixed character of the villages in Bilanga department that borders on Kouritenga province with its Mossi population. Historically there has been a lot of interaction between the various groups on this ethnic borderland. In terms of the agricultural system the Mossi are very similar to the Gourmantché. The Rimaïbè, which have their origin as former captives of the Fulbe, combine attributes of the Mossi/Gourmantché sedentary agricultural society with aspects of the semi-sedentary livestock herding Fulbe. In population censuses they are often enumerated as Fulbe, probably also because Fulfuldé is their first language. Another difference, which is not apparent in the numbers themselves, is that the presence of the Fulbe (and the other ethnic groups) in Samboanli goes back much further than in Pentouangou. In Pentouangou the first Fulbe settlement dates back to 1969, while the majority arrived around 1985 and later. In Samboanli, Fulbe and Rimaïbè were present on the territory some 100 years ago and then fled during one of the armed struggles between the chieftainship of Boulsa and the chieftainship of Bilanga. Also during the colonial period Mossi, Fulbe and Rimaïbè continued to move back and forth between the Boulsa canton and the Bilanga and Bilanga-Yanga cantons, as is evidenced from life histories and colonial reports (RAP.TOA.37; RAP.TOA.53-54). The majority of the Fulbe and Rimaïbè who had lived on the Samboanli territory before colonization, returned again to Samboanli more than 60 years ago (Diallo 1997). The difference in duration of inter-ethnic cohabitation between Pentouangou and Samboanli had an important impact on Gourmantché-Fulbe relations as we shall see in chapter 8.

Social organization and lifestyle

In administrative terms there are also some differences between the two villages. Samboanli as a whole is administratively considered as a ward of Bilam Perga (see map 3) and is as such not officially recognized as a village. However, it is considered as a separate village by its inhabitants and it has its own chief. Pentouangou, on the other hand, is both traditionally and administratively recognized as a village. While the chief of Samboanli is subordinate to the chief of Bilanga, the chief of Pentouangou is subordinate to the king in Fada N'Gourma, reflecting historical divisions between specific chiefs of the eastern region (chapter 7).

There are important differences between the villages in the way in which elements of a "traditional" and "modern" lifestyle have been integrated. In Samboanli, traditions seem to play a more active role in every day life than in Pentouangou. For instance, the Fanfama festival that takes place when the harvest has been good, is celebrated more frequently in Samboanli than the corresponding festival in Pentouangou (see also chapter 7). There seems to be a much stronger sense of cohesion between the villages in the area where Samboanli is located. The chief of Bilanga, the traditional ruler over this area, also seems to play a much more pronounced and direct role in both cultural and political affairs than the corresponding chief in Fada N'Gourma plays for Pentouangou.

An important indicator of "traditional" values is also the structure and size of the Gourmantché compounds. As can be seen in table 4.6, Gourmantché households in Samboanli are larger and there are more households per compound, which leads to compounds with more than twice the number of members than in Pentouangou. In fact, quite a number of compounds in Samboanli retained the traditional patrilineal extended family structure that was typical for the Gourmantché way of living in the past but in many cases has been lost due to the processes described earlier (section 4.5.3). Pentouangou, on the other hand, has very few truly large compounds left, except for the chief's compound. Social life seems to be more individualized as can be seen by the fact that in Pentouangou 70% of the Gourmantché compounds consist of a single household, whereas this figure is only 45% for the predominantly Gourmantché wards of Samboanli (see section 4.8.2 for a discussion of the wards).

The greater role of traditions in Samboanli, however, does not mean that it is less integrated in the wider region. Table 4.6 shows that in Samboanli more languages are spoken by married Gourmantché adults than in Pentouangou. This may at least partly be attributed to the multi-ethnic environment of the village itself. Samboanli also has a much higher percentage of French speaking adults than Pentouangou. This can be attributed to several aspects. The first is education. While both villages had a rural school (école rurale, see section 4.7.1) in their vicinity, the one near Samboanli was operational for a much

Table 4.6 Selected characteristics of the Gourmantché population of the main research villages

	Samboanli	Pentouangou
	Compound structure and size	
Household size (persons)	9.4	7.7
Households per compound	2.8	1.6
Compound size (persons)	26.6	12.1
	Languages spoken by married adults	
Gourmantchema	100%	100%
French	13%	9%
Mooré	72%	26%
Fulfuldé	18%	2%
	Religions practiced by married adults	
Traditional religion	80%	99%
Islam	69%	4%
Catholicism	16%	31%
Protestantism	3%	6%

Source: 1996 village census.

longer period of time and has been more successful. This school, located at the border of the Samboanli village territory, next to the road between Bilanga and Bilanga-Yanga, dates from the early 1960s and closed down in the early 1990s. Quite a number of today's adult men have been to that school for a few months up to a few years, learning some French and some modern agricultural techniques. The rural school near Pentouangou was located in neighboring Kikideni and operated between 1969 and 1986 (interview with Malyombo and Foldia Thiombiano[56]). Also here some of the villagers attended for a couple of months up to several years. This school was, however, much less successful as some villagers explained that the teacher was not really interested and would regularly disappear to Fada for a drink. There are also several other primary schools available near both villages, but we have the impression that villagers in Samboanli make more use of them than those in Pentouangou.

A second factor explaining the differences in terms of the languages spoken is migration.[57] From the questions on migration in the village survey (chapter 3), it follows that in Samboanli migrations by the Gourmantché villagers started earlier, with almost 10% of the trips taking place in the 1950s and 1960s, whereas the first recorded trips for Pentouangou were in the 1970s. In Samboanli migration is also more widespread, involving 27% of the Gourmantché villagers compared to 17% in Pentouangou. Furthermore, in Samboanli people stayed away from the village for more time (60% stayed away for more than six months) and traveled greater distances (65% left the eastern region and as much as 47% left the country) than in Pentouangou where only 20% stayed away more then six months and only 40% left the eastern region (and just 21% left the country). All these figures indicate that in Pentouangou travelling began much later and was more limited in spatial range, though in recent years migration has grown in popularity, with almost 60% of the reported trips taking place in the 1990s. Through migration people learn new languages.

As table 4.6 shows, there are also important differences between the villages in terms of religion. In Pentouangou virtually all of the Gourmantché inhabitants claim to still practice a traditional religion, while only 40% practices one of the "new" religions: Islam, Catholicism and Protestantism. In Samboanli almost 90% of the Gourmantché married adults (also) practice one of the new religions. This difference is remarkable if one considers that the oldest catholic and protestant missions of the region were based in Fada N'Gourma and that the protestant mission around 1950 started a bible school in Niendouga, a village neighboring Pentouangou (see map 3). It appears that only recently Christianity, which is associated with a modern lifestyle, is gaining importance in Pentouangou. For Samboanli, instead, Islam, which is locally also considered a modern religion, is much more important.

The greater outward oriented character of Samboanli reflects its longer and more active involvement with markets and trade. This topic is treated in chapter 7.

Agriculture

In terms of agriculture there are some notable differences between the villages that largely

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[56] Interview on 27 September 1997, Pentouangou.

[57] Migration is defined here as trips with a duration of one month or more.

correspond to the differences between Gnagna and Gourma provinces. In Samboanli more groundnuts and sesame are grown than in Pentouangou. In Samboanli farmers used to grow rice in the central bottomland that cuts across the village, but stopped to do so when the amount of rainfall decreased. Farmers in Pentouangou, on the other hand, only recently began with rice cultivation, in the large bottomlands that border the village territory. In Pentouangou, minor parts of these bottomlands are now also used during the dry-season to grow well-irrigated horticultural crops for sale.

An important historical difference between the villages is that in Pentouangou, with large tracts of uninhabited bush in its vicinity, hunting and gathering continued to play an important role for a much longer time than in Samboanli. In the nineteenth century and early twentieth century meat of wildlife and bush products formed an important source of subsistence in Pentouangou. As 79 years old Toumbengu Thiombiano explains:

> At the time of my grand parents people hardly cultivated. Some went hunting, with bows and arrows. Hunting elephants, antelopes or gazelles. There was more than enough meat, and honey as well. They cultivated very little millet and sorghum. A cob of maize was enough to feed a child, they did not cultivate much. Later, during the reign of Bantchandé [1892-1911] people started to cultivate a lot. Even those that had been specialized in hunting elephants.

Livestock ownership among the Gourmantché in Samboanli is much more widespread than in Pentouangou.[59] This difference in cattle ownership has its historical roots. As data from livestock censuses in the mid 1930s indicate, the villages in the area around Pentouangou had a much smaller livestock population than those in the area around Samboanli. In 1937 the cattle density in the Bilanga and Bilanga-Yanga cantons was already above 2 heads km^{-2}, while there was about one goat or sheep per three persons (REC.37). In the area around Pentouangou cattle ownership was largely restricted to those villages that had a Fulbe or Mossi population, while also the numbers of goats and sheep per head was limited (REC.36). The 1936/37 census reports reveal some other interesting facts about the research villages and their surrounding. One interesting point is that also the number of bush compounds were recorded during the census. One fourth of the villages of the Bilanga canton had one or more bush compounds. Bilam Perga (referred to as Bilanga Corga in the census), the village of which Samboanli is administratively part, had as many as 22 bush compounds at distances of up to 25 km from the village (REC.37). In the Pentouangou area virtually all villages had bush camps. For Pentouangou, with a population of 273 inhabitants, 12 bush compounds were recorded at distances of up to 5 km from the village (REC.36). This confirms the importance of bush compounds in the livelihood strategies already early in the twentieth century (section 4.5.3).

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[59] Because of the sensitivity of the matter of livestock ownership no attempt was made to quantify this, but it is safe to assume that the number of cattle owned by Gourmantché in Samboanli is several times greater than in Pentouangou.

4.8.2 The ward structure of the main research villages

So far we have been looking at the research villages as a whole. There are however notable differences between the different village wards. Each of the wards is therefore discussed below (see also map 4 for the approximate current locations of the wards).

Samboanli

In Samboanli each ward has its own particular history and population mixture that is reflected in the data presented in table 4.7. Koksi, Kolonkuomi, and Samboanli (ward with same name as the village) are the oldest wards with a virtually Gourmantché-only population. In Koksi and Kolonkuomi there are some Gourmantché Mossi intermarriages (in most cases of a Gourmantché man and a Mossi woman). In the Samboanli ward the situation is comparable except that it also has one Fulbe compound. As can be seen in table 4.7, all three wards show a high average number of inhabitants per compound. There is a considerable range in compound sizes: the two smallest compounds have, respectively, 5 and 6 members while the two largest compounds have as many as 62 and 90 members, respectively.

Kalinkami is a more recent ward, of which most of the inhabitants settled in the village between 1981 and 1985, but some as far back as 40 years ago. This ward has some Gourmantché, some Mossi and some mixed compounds, as is also reflected in the relatively high percentage of multi-ethnic households. This ward has grown because a number of families from nearby Bilam Perga (see map 3) started coming here during the rainy season. Eventually their rainy-season compounds developed into permanent settlements. The recent nature of these compounds and their origin as rainy-season living quarters also explain the

Table 4.7 Selected characteristics of the six wards of Samboanli

	Koksi	Kolonkuomi	Samboanli	Kalinkami	Tampagdi	Peul	Total
	Social organization						
Number of inhabitants	137	77	138	145	108	51	656
Number of households	15	8	17	12	13	5	70
Number of compounds	6	2	4	9	9	4	34
Inhabitants per compound	23	39	35	16	12	13	19
	Ethnic composition						
Gourmantché	94%	95%	84%	68%	1%	0%	64%
Fulbe	0%	0%	14%	0%	0%	100%	11%
Rimaïbè	0%	0%	0%	2%	45%	0%	8%
Mossi	6%	5%	1%	30%	54%	0%	18%
Multi-ethnic households	20%	13%	12%	33%	69%	0%	27%
	Crop cultivation						
Inhabitants with bush camp	27%	42%	69%	13%	19%	0%	31%
Married women cultivating	97%	100%	86%	100%	100%	0%	87%

Source: 1996 village census.

relatively low number of inhabitants per compound, though there is one compound with as many as 43 members.

Tampagdi is a mixed Rimaïbè-Mossi ward that dates back at least 60 years and slowly grew over the last decades. The majority of the households are multi-ethnic and the lifestyle is dominated by the mixed farming practiced by the Rimaïbè. The Gourmantché therefore often refer to this as the black Fulbe (the local expression for Rimaïbè) ward. The compounds are much smaller than those of the Gourmantché, with the largest compound counting 27 members.

The Peul (French for Fulbe) ward is found a little further outside the village center (Koksi) to limit livestock damage to the crops during the rainy season. This ward is at least 60 years old and consist only of Fulbe. Also here the compounds are relatively small, with the largest having 24 members.

Further differences between the wards are the proportion of the population staying for six or seven months per year in a bush camp (table 4.7). In Koksi, Kolonkuomi and Samboanli bush camps are relatively important with one third to two thirds of the inhabitants living in bush camps during the rainy season. In Kalinkami and Tampagdi this phenomenon is much less pervasive, in the first case because fertile land for cultivation is still available nearby and in the second case because cultivation plays a smaller role for most of the Rimaïbè families and they have well manured village fields available. The Fulbe cultivate even less and for them compound and village fields are therefore sufficient. As can be seen in table 4.7 the Fulbe women do not cultivate at all, whereas all able-bodied Gourmantché, Mossi and Rimaïbè women cultivate their own fields and those of their husband.[59]

In terms of the bush camps it is important to note that they are not restricted to the village territory. Inhabitants from other villages have bush camps on the Samboanli territory just as inhabitants from Samboanli have bush camps on for instance Tiambargou and Bilanga territory. In all cases after obtaining permission from the owners of the land (often relatives).

Pentouangou

Also in Pentouangou there are clear differences between the wards as can be seen in table 4.8. In terms of ethnic composition the wards can be divided in pure Gourmantché and pure Fulbe wards. There are no intermarriages. With just a few exceptions, all compounds in the Pentouangou, Duolipo and Diababgnanli wards are native to the village. Pentouangou and Duolipo form the center of the village whereas Diababgnanli is a rainy-season bush camp that eventually became a permanent settlement with two compounds. So permanent in fact, that two of the three households now go to another location during the rainy season. Cultivating in bush camps during the rainy season is even more popular in Pentouangou than in Samboanli. More than half of the Gourmantché stay in bush compounds for six to seven months per year, in Duolipo even as much as 91% of the population. In the village

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[59] The relatively low percentage of cultivating women for the Samboanli ward is caused by the women of the Fulbe compound in that ward that do not cultivate.

Table 4.8 Selected characteristics of the six wards of Pentouangou

	Pentouangou	Duolipo	Diababgnanli	Peul 1	Diakabé	Peul 2	Total
	Social organization						
Number of inhabitants	215	159	36	111	102	99	722
Number of households	29	21	3	9	11	12	85
Number of compounds	18	14	2	6	9	9	58
Inhabitants per compound	12	11	18	19	11	11	12
	Ethnic composition						
Gourmantché	100%	100%	100%	0%	0%	0%	57%
Fulbe	0%	0%	0%	100%	100%	100%	43%
Multi-ethnic households	0%	0%	0%	0%	0%	0%	0%
	Crop cultivation						
Inhabitants with bush camp	52%	91%	67%	0%	0%	0%	39%
Married women cultivating	98%	100%	100%	25%	0%	0%	60%

Source: 1996 village census.

Note: The ward names Peul 1 and Peul 2 were given for convenience as there seemed to be no unambiguous local names.

the number of inhabitants per compound averages some 11 to 12 persons, whereby the smallest compounds number 3 or 4 inhabitants and the two largest ones 24 and 53 respectively. In general the compounds are significantly smaller than in Samboanli. All able-bodied women engage in agriculture.

The Fulbe wards are relatively recent. The oldest one is Peul 1 which was established around 1969. Diakabé and Peul2 where both established around 1980, but continued to grow in more recent years, with a major influx around 1985. Compound sizes are relatively small with an average 11 members for Diakabé and Peul 2 and a range of 5 to 18 members. Peul 1 has relatively large compounds, ranging from 7 to 24 members. This difference can probably be explained by the longer existence of this ward. None of the Fulbe have bush camps and with the exception of some of the women in Peul 1 the Fulbe women do not cultivate.

4.9 Conclusion

This chapter has introduced the research area and the research villages, discussing both the historical developments since the colonial conquest in the last decade of the nineteenth century and the present livelihood and farming system. Several important developments were discussed that have significantly altered the social organization and the livelihood system. Notably, an increased individualization of production and consumption in conjunction with a decline of traditional authorities, an increased cultivation in bush camps, more extensive livestock ownership among the Gourmantché, and an increased monetization and market orientation. These changes have been spurred, among others, by oppressive colonial practices and increased market integration. The latter of which will be discussed in much more detail in chapter 7. At the same time, population and livestock densities have risen steeply, raising the question how this has influenced the state of natural resources, an issue that will be dealt with in chapter 5. Finally certain aspects of changes in the farming system are dealt with in greater detail in chapter 6 and 8.

Aside from depicting the setting, this chapter also has another important function, it allows the research area and research villages to be placed within a wider context. In terms of the physical environment and in terms of the agricultural system and the crops grown, the research area and villages are representative for the Sudano-Sahelian and southern Sahelian zone in Burkina Faso. Even though the Gourmantché do not live outside the eastern region, their way of living and their livelihood system are not radically different from the Mossi, who form the largest ethnic group of the country. In addition, the Fulbe and Rimaïbè, who make up some 6 to 8% of the population and live in separate wards and sometimes villages throughout the region are also found in many other parts of the country.

A difference with large parts of the country is the relatively low level of development intervention found in the eastern region. However, as was argued in chapter 3, this was one of the reasons to work in this area in the first place. We wanted to find out what kind of soil and water conservation practices farmers would undertake on their own initiative, without being influenced by current monetary or in-kind incentives offered by projects to adopt certain practices. However, as pointed out by a rapid appraisal (chapter 3), the low level of intervention has not led to a much different repertoire of local soil and water conservation practices from that found elsewhere in the Sudano-Sahelian and Sahelian ecological zones of Burkina Faso.

Another important point to consider is population growth and density. It was pointed out in chapter 2 that population growth and density play a major role in the land degradation debate. Section 4.3.2 pointed out that Gnagna province, with a rural population density of 35 inh. km^{-2} is above the national average (30 rural inh. km^{-2}) for the Sahelian zone, while Gourma and Tapoa provinces, instead, are, with respectively 13 and 16 rural inh. km^{-2}, considerably below the national average of the Sudano-Sahelian zone (34 rural inh. km^{-2}). This strong contrast may be considered an advantage to study the role of population pressure in explaining land degradation and the use of soil and water conservation practices. As section 4.8.1 showed, the difference between the main research villages is even more extreme, with the southern village having a population density similar to the rural average for the Gourma province (13 inh. km^{-2}) and the northern village having a population density as high as 50 inh. km^{-2}. While there are other villages in the Sahelian zone with even higher population densities, the density in the northern research village is on par with the rural averages for the most densely populated provinces of the Sahelian part of the Central Plateau, such as Sanmatenga and Yatenga provinces. The strong growth in human and livestock population in the eastern region since independence, noted in section 4.3.2, may also be considered an advantage when studying the impact of population on land degradation and soil and water conservation.

In sum, it may be concluded that, despite some differences between the eastern region and other parts of the country, the similarities in livelihood system, soil and water conservation practices, and population growth are such that some of the conclusions drawn on the basis of this case study may have more general validity to Burkina Faso, as well as other parts of the West African Sudano-Sahelian belt.

Plate I. Making shea butter

Plate II. Spinning cotton string

Plate III. Weaving cloth

5. Land degradation in perspective

> We currently lack much of the baseline knowledge we need to properly determine ecosystem conditions on a global, regional, or, in many instances, even a local scale. The dimensions of this information gap are large and growing, rather than shrinking as we would expect in this age of satellite imaging an the Internet. (World Resources Institute 2000: 9)

For several decades, soil and water conservation has been seen as a solution to perceived land degradation problems in large parts of West Africa. In chapter 2, based on several recent studies (Fairhead and Leach 1996; Leach and Mearns 1996; Afikorah-Danquah 1997; Kepe 1997; Fairhead and Leach 1998), it was argued that land degradation in an area should not be taken as a given fact, but studied within the context of the dynamics of changing landscapes and societies. Understanding these dynamics is a prerequisite to understanding how farmers do or do not conserve soil and water, which will be the topic of the coming chapters. This chapter, instead focuses on a multi-scale analysis of the environmental dynamics and current degree of land degradation in Burkina Faso, the eastern region, and the research villages.

The chapter deals with the concept of land degradation in section 5.1. This is followed, in section 5.2, by a discussion of the current land degradation narrative and the evidence on which it is based. Section 5.3 discusses the environmental dynamics in Burkina Faso and the research villages to show why a simple uni-directional linear representation of environmental change is inadequate. Finally, the major part of the chapter examines the evidence for soil degradation, one of the most prominent aspects of land degradation. This is done at three scales: the national, regional, and village level, in respectively sections 5.4, 5.5, and 5.6. The chapter ends with a conclusion.

5.1 The concept of land degradation and its operationalization

5.1.1 Conceptualizing land degradation

As was pointed out in chapter 2, land degradation is a value-laden term of which the perception is influenced by both culture and society. It is therefore impossible to give an objective and neutral definition of land degradation, of which the interpretation is not in one way or another open to debate. This complexity can best be highlighted by looking at two very different types of definition of land degradation. A verbose and very explicit definition is given by the Convention to Combat Desertification (CCD 1997: 7-8):

> "Land degradation" means reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land use or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and (iii) long term loss of natural vegetation;
>
> [Whereby] "land" means the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system;

A definition given in more general, less specific terms, such as the one given by Blaikie and Brookfield (1987: 1), who describe land degradation as a decline in productivity of land in relation to actual or possible uses and hence a problem for those who use the land.

Each of these definitions has its pitfalls,[60] but they also have important common ground. Both hinge on a reduction, loss, or decline of productivity of land. In practice, however, the biological and economic productivity mentioned in the first definition will often be conflicting. Replacing a natural ecosystem with cropland will often lead to an improved economic productivity, whereas it may be regarded as a loss in terms of biological productivity. This contradiction is made explicit by the third process mentioned in the CCD definition that expressly suggests that long term loss of natural vegetation leads to land degradation. This implies that what one stakeholder (e.g., a farmer) may see as an increase in (economic) productivity, another one (e.g., a conservationist) sees as a decline in (biological) productivity. Neither definition provides a solution to this problem. In fact, the CCD definition further complicates matters by including also the aspect of "complexity" (probably in an attempt to cover biodiversity issues). A change from a low-input manual farming system to a high-input mechanized farming system is likely to lead to an increased economic productivity, but also to a reduction of ecological complexity as fertilizers, biocides, and heavy machinery kill most of the non-crop plant and animal species.

In other words, one of the key characteristics of land degradation is precisely that it cannot be objectively defined but rather, is a social construct, which leans on cultural, ethical, esthetical, and societal interpretations and valuations. This implies that in any evaluation of land degradation it is necessary to make explicit in whose terms degradation will be expressed. Aside from this very important issue, there is a second problem that relates to the evidence on which the land degradation narrative is based. This evidence itself is far from indisputable and it therefore makes sense to first question this evidence before addressing the problem of how different stakeholders would interpret this evidence. To give an example: the land degradation narrative claims that tree cover in Burkina Faso is rapidly

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[60] CCD (1997), for instance, restricts the definition of land degradation to arid, semi-arid, and dry sub-humid areas. A restriction for which there are no scientific grounds, but which is probably a reflection of the fact that the focus of the CCD is on desertification.

declining because of an expansion of the cultivated area (section 5.3). The first question would be whether tree cover is really declining rapidly and the second question would focus on whether this is good or bad from stakeholders' points of view. The land degradation narrative rest on two premises: (1) that there is a change in the productivity of the land, and (2) that this is a change for worse. Our focus in this chapter will be on the first premise because it forms the (scientific) foundation of the narrative and because addressing both issues at once would not contribute to the clarity of the argument. Furthermore, if the first premise does not hold, the second one becomes much less pressing.

This chapter will therefore evaluate the various forms of evidence of land degradation as they are used within the dominant scientific paradigm, which bases itself on, for example, crop yields, population pressure, erosion measurements, nutrient budgets, and long-term experimental plot data (e.g., Roose and Piot 1984; Pieri 1986; Stoorvogel and Smaling 1990; Ramaswamy and Sanders 1992; van der Pol 1992; Cleaver and Schreiber 1994; Bationo *et al.* 1998; Breman 1998). Using these same kinds of evidence, we will try to develop a more articulated view on the condition of the land. For degradation of cultivated land we will primarily look at agricultural productivity per unit area and soil fertility. For degradation of uncultivated land the focus will be on biodiversity and, again, on soil fertility. We are aware of the limitations inherent in these indicators (section 5.2), but believe that through triangulation such quantitative indicators can contribute to a better understanding of the processes affecting the land, especially when this evidence is combined with other forms of evidence as will be done in subsequent chapters.

5.1.2 The operationalization of the concept of land degradation

After having discussed land degradation in conceptual terms, we now focus on the practical operationalization of the term. What does land degradation imply in practice and how is it measured?

Land degradation is sometimes interchangeably referred to as soil degradation. Strictly speaking this is incorrect. Soil degradation is a form of land degradation, but not the only form. In low-input agricultural systems, such as those in much of West Africa, it is probably the most important form of land degradation as, by virtue of cultivation, natural flora and fauna have already been largely removed from fields, and pollution, by for example, heavy metals, herbicides, and insecticides are not an issue. However, looking at the agro-ecosystem as a whole, including fallow, pastures, and other uncultivated areas, a discussion cannot limit itself to soil degradation, but should also look at issues such as degradation of vegetation. Rather than attempt to operationalize the concept of land degradation straightaway in its entirety, the most important sub-terms in the West African context, soil degradation and vegetation degradation, will first be dealt with separately.

Soil degradation is very difficult to measure because, being a component of land degradation, it is defined in terms of a loss of productivity (of the soil in this case). A change in productivity generally cannot be attributed solely to a change in the quality of the soil. Productivity is at least as much affected by changes in water-availability, agricultural, or range management practices, or in the case of cultivated land, factors such as labor input, technology, and crop selection. As a consequence, biomass production (or crop yield) can only serve as a first proxy to soil degradation that needs to be supplemented by corroborative evidence from actual measurements of the state of the soil. The opposite is also true. Because soil degradation is defined in productivity terms, one cannot limit oneself to soil measurements alone. Changes in the soil do not necessarily lead to a productivity decline. Due to the multivariate and inter-dependent nature of the soil and its productivity, this creates a kind of deadlock when attempting to measure soil degradation. Neither direct measurements of the productivity nor of the soil material itself can unambiguously define soil degradation. What is worse, even a decline in both productivity and certain soil qualities are insufficient evidence to conclude that soil degradation is taking place, because the decline in productivity may have been caused by other factors than the decreased soil qualities. This implies that, in theory, an endless range of variables affecting productivity (both soil related and otherwise) should be investigated in order to say anything about soil degradation. In practice, it implies that any variable used to say something about soil degradation is little more than a proxy. Some of these proxies are better than others, but all to some degree require corroboratory evidence from other proxies to increase the validity of their interpretation.

The difficulties in using proxies to establish soil degradation is well illustrated with the example of soil erosion, one of the most common proxies used for that purpose. Soil erosion has been a major concern ever since (but also before) the so-called Dust Bowl experience in North America during the 1930s, but as Stocking (1987: 62) rightly remarks, "some soils may suffer much erosion and be relatively unaffected [in terms of productivity], while others need only a very small quantity of soil loss to decline dramatically in yield levels." According to Dregne (1990) this relationship between erosion and soil productivity has until recently been insufficiently studied, especially in the African context, and is therefore inadequately understood.

Given the problematic operationalization of the concept of soil degradation and the costs of direct measurements, any sweeping statements about soil degradation should be considered with skepticism. Such statements are at best based on proxies and at worst inferred from gross generalizations and extrapolations. For instance, most maps of soil degradation are typically inferred from variables such as the erosivity of rainfall, the angle and length of the slopes, and the expected erodibility of the soils (e.g., Somé *et al.* 1992). Because of the variables taken into account and the limited detail of the available data, such maps are often not even proxies for soil degradation but rather proxies for the soil degradation susceptibility of an area. Other approaches, such as the Universal Soil Loss Equation (USLE) suffer from comparable limitations (Stocking 1987). In other words, statements about soil degradation should not be taken at face value.

The operationalization of the concept of vegetation degradation (a decline in productivity of the vegetation) poses quite different problems. It is less complex in that direct measurements of the properties of the vegetation can be used, whereas soil degradation requires both direct measurements (of soil) and indirect measurements (of productivity). In the case of soil degradation there is, however, much less dispute possible on what should be measured than in the case of vegetation degradation. Soil physical and chemical properties are often correlated and soil scientist will easily find common ground on the specific properties that should be measured to express the state of soil degradation.

In the case of vegetation there are, however, quite a number of potentially contradicting measurements possible: total biomass production, above ground biomass production, ground cover, complexity, specific species composition, biodiversity, economic value of wood, medicinal properties of plants, etc. The range of possibilities easily reverts to the earlier mentioned issue of culturally and socially dependent valuation of resources (see also de Groot (1992) who discusses this issue in the context of environmental assessments). An economically productive stand of teak or eucalyptus may not be ideal in terms of biodiversity or might have replaced a local plant community that was rich in medicinal properties. In any discussion of vegetation degradation a decision will thus have to be made about the terms in which the degradation will be measured and expressed.

Perhaps more problematic is the fact that it is not so easy to define an objective reference point to which vegetation should be compared in order to measure the decline in productivity and/or complexity. Usually concepts such as natural vegetation and climax vegetation are used as points of reference, but as was already pointed out in chapter 2, this hides the dynamics of vegetation changes and suggest a kind of uni-directional linear development of vegetation communities. Again, an explicit decision will thus have to be made on what the point of reference will be: a specific point in the past or some kind of ideal natural or climax vegetation.

As both soil and vegetation degradation are difficult to measure so is the overarching concept of land degradation. Only through the use of proxies and explicitly defined criteria and points of reference is it possible to say something about land degradation. Any statement on land degradation that is not accompanied with details on these issues should thus be treated with caution.

5.2 The land degradation narrative explored

5.2.1 Land degradation in Burkina Faso and the eastern region

UNEP (1997), basing itself on the Global Assessment of Human-Induced Soil Degradation (GLASOD) database,[61] holds that almost 30% of the East and West African Sahel region is affected by human-induced soil degradation. For about half of this area soil degradation is moderate to extreme (UNEP 1997: table 2.2). It has been widely claimed that land degradation has also become widespread in Burkina Faso through a combination of factors, including repeated cycles of drought, increased population pressure on natural resources, deforestation caused by firewood demands, uncontrolled migration, and inappropriate agricultural and pastoral practices (see for example Vierich and Stoop 1990; Ramaswamy and Sanders 1992; MFP 1993; PNGT 1993; Kessler *et al.* 1995; MEE 1996). Although MET (1994: 53) cites a 1990 World Bank report that estimates that the costs of land degradation amount to 20% to 25% of the GDP, there is little quantitative data available on the actual state of land degradation in Burkina Faso. MET (1994) cites a 1992 World Bank publication reporting an annual deforestation level of 800 km^2 per year between 1981 and 1985. As part of their continental level study Stoorvogel and Smaling (1990), based on a

[61] For details on the GLASOD methodology see Oldeman *et al.* (1991).

1983 nutrient balance, give figures for nutrient depletion in Burkina Faso, estimating annual nutrient losses in the order of 12 and 14 kg ha^{-1} for potassium (K_2O) and nitrogen (N), respectively, and 4 kg ha^{-1} for phosphorus (P_2O_5). These figures suggest serious losses of chemical soil fertility pointing to considerable soil degradation. Somé *et al.* (1992) combined information on geology, geomorphology, soils, rainfall, vegetation, and human influence to produce a map of land degradation for Burkina Faso. If we carry out some calculations on this map, it appears that as much as 75% of the country is affected by important to very severe degradation.[62] In other words, it may be said that land degradation is generally believed to be prevalent in Burkina Faso and that the few available figures support this idea.

Also the research area, the country's eastern region, is said to be suffering from land degradation, though less so than the more densely populated Central Plateau. According to INERA (1993) Gnagna province is suffering from medium land degradation and Gourma and Tapoa provinces from light degradation. Following predictions presented in Parkan (1986: 59-61) the eastern region is rapidly loosing its natural vegetation: between 1983 and 1995 some 330,000 ha of its forest and natural savanna cover was predicted to be lost (some 10% of the 1983 area). Following the earlier mentioned map of Somé *et al.* (1992) we find that about 30% of the eastern region was classified as severe to very severely degraded and some 40% as showing important degradation. In other words, also here land degradation is serious, but not as alarming as in certain other parts of the country (notably the Central Plateau).

5.2.2 Examining the evidence

It is surprising to see that land degradation is taken as a given by the majority of studies on agriculture in Burkina Faso, while there are only few sources available which attempt to quantify and map this degradation. Are we dealing with a development narrative (chapter 2) that has transformed few actual measurements and observations into a self-enforcing story? Given the difficulty of actually measuring land degradation it is worthwhile to take a closer look at the evidence on which the land degradation narrative is based. Broadly speaking there are five types of evidence: (1) declining crop yields; (2) pressure of population on resources; (3) erosion measurements; (4) nutrient budget studies; and (5) long-term experimental plot studies. Below, the shortcomings of each of these will be briefly discussed to indicate why the evidence on which the land degradation narrative for Burkina Faso is based, not only falls short because only few studies actually investigated the evidence, but also because of the limitations of the data and methodologies used to provide the evidence.

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[62] On the basis of this map, it may be concluded that 25% of the country is affected by very severe degradation, 35% by severe degradation, almost 15% by important degradation, 13% by medium degradation, 10% by light degradation and 2% by very light degradation. The 2% of the map classified as protected areas were excluded from the calculations.

Crop yields

It is widely believed that as a result of land degradation and over-exploitation, crop yields have been declining in Burkina Faso and other West African countries (see for example Ramaswamy and Sanders 1992; Bationo *et al.* 1998). But how good an evidence are crop yields, and are they really declining? In theory, crop yield could be a very sensitive indicator of land degradation were it not that yield is affected by a wide range of conditions (Lavigne Delville 1996). It depends on the crop variety or landrace and is affected by changes in labor availability, technology, pests and diseases, and water availability. Crop variety is seldom taken into account in production statistics, while long-term measurements of labor input, technology use, and pests and diseases that could be related to yield changes are non-existent and would be virtually impossible to collect under local farm conditions without enormous expenses. Rainfall measurements are probably the most accessible source of data, but because of the high spatial variability in terms of rainfall levels and distribution and the fact that the estimation of water availability requires soil data, they remain of limited value. Still, if there is one thing apparent from the available rainfall measurements, it is a downward trend since the wet 1950s (section 5.4.1). A trend that could very well account for quite a number of cases of decreasing yields as Pieri (1989) observes. But, is the decline in yields that is mentioned by both farmers (also in our study villages) and development workers and researchers (e.g., Powell and Williams 1993; Savadogo *et al.* 1998), really occurring? According to the national level analyses that Pieri (1989: 79-90), who actually looked at the available data, did for a number of West African countries, there is, with a few exceptions, no yield decline in the last 30 to 60 years for the most important crops. For some crops (such as millet in Burkina Faso and maize in Mali) there has even been a yield increase. Scoones and Toulmin (1999) did a similar analysis for maize in several African countries and found no yield decline. As Pieri (1989) rightly points out, such national level analyses leave many questions unanswered. We will therefore combine an analysis of national yield trends (section 5.4.2) with a series of analyses at sub-national level in order to gain a better insight into the causes and effects of changing yield levels (section 5.4.3).

Population pressure on resources

The pressure of a growing population on the limited natural resources is often cited as one of the major factors leading to land degradation (see for example Vierich and Stoop 1990; MFP 1993; Cleaver and Schreiber 1994; Kessler *et al.* 1995; Bationo *et al.* 1998; Breman 1998). This point of view is however contested as we have seen in chapter 2. On the one hand, there is the neo-Malthusian view that population carrying capacity is limited by resources and the state of technology. On the other hand, there is the Boserup hypothesis that population is an independent variable and that population growth is a major determinant of technological change in agriculture (Blaikie and Brookfield 1987: 29). In the first case, population growth may lead to a doom scenario whereby it leads to land degradation, lowering food production, and eventually engenders starvation. In the second case, population growth may form the impetus for technological innovation leading to improved land care and rising food production (chapter 2). Also in the latter case population growth may however lead to land degradation as population density may not yet have reached the point whereby technological innovations pay-off. Both neo-Malthusians and Boserupians thus see population pressure on resources as an important factor in explaining land degradation. In either case, agricultural intensification (whether introduced from outside or produced through internal processes) is required to prevent over-exploitation. As there is no doubt that population has grown dramatically during the course of the twentieth century the question thus becomes whether there has been sufficient intensification of agricultural production. If mechanization and external inputs in the form of mineral fertilizers, herbicides, and pesticides are considered the main forms of intensification, this question is answered negatively for Africa (Scoones and Toulmin 1999), which easily leads to the conclusion that population growth must have led to land degradation. As we will argue later in this chapter and in the remainder of this study, this might very well be a gross simplification of the kind of intensification that is required to prevent land degradation under a growing population. In section 5.3 it is examined to what degree population pressure has led to vegetation degradation at both the national and local level, while sections 5.4, 5.5 and 5.6 look at the impact of population pressure on soil degradation, at the national, regional, and local level, respectively.

Erosion measurements

Erosion measurements have long formed an important source of evidence for land degradation. Ever since the US "Dustbowl" experience of the 1930s, erosion has been recognized as an important source of soil degradation. Over several decades such measurements have led to worrying conclusions about land degradation in the Sudano-Sahelian zone (e.g., Roose and Piot 1984). There is no doubt that the soils in this region are particularly prone to erosion and that the intense rainstorms in this area have a high erosivity. Still, care needs to be taken in the interpretation of the results of these measurements because they have been largely carried out on experimental sites and not on farmer fields. It is also doubtful whether such experimental results can actually be extrapolated to the watershed level, let alone to the regional or national level (see Stocking (1996) and Scoones and Toulmin (1999) for more extensive discussions of the limitations of erosion measurements in the African context). Plot level data tends to over estimate erosion because it does not take into account the fact that at watershed level there are both erosion and sedimentation sites (Stocking 1996). As was observed by our informants (chapter 6), even single fields have erosion and deposition areas (plate IV). Another aspect that is not sufficiently taken into account in erosion studies is the fact that fields are often not cultivated continuously, and especially large bush fields are left fallow from time to time. It is conceivable that erosion during cultivation is partly compensated for by sedimentation and wind-borne deposition during fallow. Furthermore, erosion-productivity relationships are difficult to establish (Erenstein 1999). Finally, the reason why erosion is considered so serious is that valuable topsoil is lost. But, in those cases where the soil is deep and poor in fertility, this topsoil may not always be that much more fertile than the subsoil. Smaling (1993: 85), for instance, notes that nutrient budgets are only slightly negative in Africa's semi-arid countries because among other factors, soils are poor and have little to lose anyway. Despite the many uncertainties, the factor erosion figures, nevertheless, pronouncedly in the nutrient budget studies discussed below.

Nutrient budget studies

Since the late 1980s model studies based on nutrient input-output budgets (also referred to as nutrient balances) form an increasingly important source of evidence on land degradation. These studies (e.g., Pieri 1989; Stoorvogel and Smaling 1990; van der Pol 1992; Smaling 1993; Smaling *et al.* 1996; Sanchez and Leakey 1997) come to rather alarming conclusions about the way African farmers are currently exhausting their soils. Van der Pol (1992: 25) in a study on southern Mali, for example, notes that "even when the most optimistic estimates are used, this study reveals the presence of large deficits for nitrogen, potassium and magnesium. These deficits are mainly caused by traditional cereal crops; however, cotton and, even more, groundnuts, both of which are insufficiently fertilized, also cause deficits." Van der Pol finally concludes that, based on his calculations, "only 60% of income is obtained in a sustainable way: the remainder is based on soil mining." These are serious allegations. And, at first inspection, there is reason to take them seriously, as the computer models that calculate the nutrient budgets are based on over 30 years of field measurements and calculations by many different researchers.

However, nutrient budget calculations suffer from the same problems as erosion plot studies. The data are often based on extrapolations and generalizations of measurements that were taken under very specific conditions, and it still remains to be seen whether they can be applied to the great variety of soils, rainfall regimes, and farmer practices in whole countries or regions (Scoones and Toulmin 1998). Furthermore, the models ignore within-soil processes and often assume linear relationships between variables, which may be unacceptable simplifications given the complexity and non-linear dynamics of the actual systems (Scoones and Toulmin 1999). A weak point is also the sensitivity of these models to factors such as erosion that are surrounded by so many uncertainties (van der Pol 1992; Smaling *et al.* 1993). In the model of Stoorvogel and Smaling (1990) for example, erosion is responsible for 35% to 45% of the annual nitrogen, phosphorus, and potassium losses in Burkina Faso according to a 1983 scenario. Because losses through erosion and crop production and residue removal figure so importantly in the nutrient balances, the scale at which the balance is applied matters a lot. According to Krogh (1997a) most studies are based on average nutrient budgets at the field scale, while the village territory might be a more appropriate scale. Given the relative importance in the Sahel of subsistence agriculture, crop production and residue removal would not be considered losses at the village level because their nutrients remain largely within the village territory. A similar remark can be made concerning erosion, a considerable part of the detached soil material probably does not leave the village territory either. A further point of critique is that the models generally lack validation with long-term fertility measurements in actual farm fields. Van der Pol's (1989: 31) figures for nitrogen, for example, indicate a mean probable net-loss of 25 kg ha^{-1} $year^{-1}$ for the whole of southern Mali. With an average 0.08% total N content in a 20 cm topsoil the total pool would be 2000 kg N ha^{-1}. With a net-loss of 25 kg

ha^{-1} $year^{-1}$ this would lead to a 20% loss in 27 years. A sufficiently large number of soil samples should be able to measure such effects if they are indeed taking place. That, however, is the question we will try to answer in sections 5.4 through 5.6.

Long-term experimental plot studies

Long-term experimental plot studies form another important source of evidence for land degradation. These studies, which are largely limited to researcher-managed, on-station trials (Scoones and Toulmin 1999), show that long-term cultivation without organic and mineral inputs lead to soil exhaustion and decreasing production, whereas plots that do receive inputs continue to give high yields (Pieri 1986; Pieri 1989). In the designs of such studies different plots receive different treatments but a single plot generally receives the same treatment for the entire duration of the experiment. This allows the scientist to analyze the impact of different treatments without the complications of assessing the role of consecutive different treatments on a single plot. Methodologically this may be a sound setup to learn about the long-term effects of single treatments, but in many cases it has little relevance for the assessment of the impact of long-term cultivation by small-scale West African farmers (Richards 1989). There is no doubt that, also on farm fields, long-term cultivation without organic matter or mineral fertilizer inputs leads to soil fertility decline, as was already reported by Siband (1972, 1974) on the basis of on-farm studies in Senegal. In many West African farming systems farmers, however, do apply inputs, leave crop residue on the field after the harvest, or practice forms of crop sequencing and crop rotation (including fallow) to maintain fertility. These practices will often be adapted to the duration a field is cultivated (note the common compound, village, and bush field management system described by for example Prudencio 1993). Furthermore, farmers may adjust their treatment precisely to the changing fertility status of a field (chapter 6). On (more or less) permanently cultivated fields they will apply inputs in response to fertility decline, while on temporarily cultivated fields they will switch to less demanding crops in response to fertility decline. In both cases the treatment thus changes with time, making it very difficult to predict the effects of long-term cultivation by farmers based on experimental plot studies. Section 5.6 investigates the consequence of this kind of adaptive management on the chemical fertility of cultivated soils in the research villages.

In sum, it may be concluded that the kind of evidence underlying the land degradation narrative, which claims widespread environmental destruction in Burkina Faso, is in many ways questionable and problematic, leading us to question the narrative itself. We will do so by re-examining the major evidence in the coming sections.

5.3 Degradation of the natural vegetation: alternative perspectives

5.3.1 National figures

Any discussion of the state of the natural vegetation in Burkina Faso is hampered by the lack of recent and up-to-date data. In 1996, the Programme National d'Aménagement des Forêts (MEE 1996) still based itself on an inventory of forestry resources dating from 1980, when it stated that 52% of the national territory (around 154,200 km^2) constitutes natural woody vegetation (mainly tree and shrub savanna).[63] Only 25% of which receives some form of official protection, mostly in the form of fauna reserves (Parkan 1986). For more recent dates, all that is available are estimates made in the mid 1980s. Parkan (1986: 50, 56, 61) estimated that between 1983 and 1995 some 110,000 to 153,000 ha of forest resources would be lost annually,[64] leading to a 10% loss of natural woody vegetation (i.e., excluding fallows and tree plantations) in 15 years. He also estimated that between the mid 1950s and the early 1980s some 30% of the natural woody vegetation cover was lost (Parkan 1986: 24). In other words, an estimated 40% of the natural forest and savanna cover was lost in the half century between 1950 and 2000, mainly due to the extension of crop and fallow land. The most recent figures are those of FAO (1999), which gives a 1995 combined forest and tree savanna cover of 42,710 km^2. Compared with the 1980 national inventory (48,480 km2, MFP 1993: 21) this suggest a 12% loss of forests and tree savannas in 15 years, which corresponds reasonably with Parkan's (1986) estimates and may thus be based on that single source. Besides the loss of natural forest and savanna cover, there is said to have been a quantitative degradation of the woody vegetation due to overstocking, pruning by pastoralists, bush fires and firewood collection, as well as a qualitative degradation due to a strong drought related mortality of woody species and a modification of the floristic composition of the herb layer (MEE 1996: 8).

Based on the above figures and observations it is easy to conclude that vegetation degradation forms an increasingly serious problem. From a forestry or conservationist perspective this is undoubtedly the case and also from a firewood perspective there is some reason for concern (though firewood is in theory replaceable by other fuels). A major question, however, is the earlier raised issue of what should be considered degradation if one land use is replaced by another. Should degradation be measured against the old forest and savanna land use (productivity of the natural vegetation) or against the new agricultural land use (agricultural productivity)? In the later case the 40% loss of natural vegetation can hardly be seen as degradation, but as an increase in agricultural productivity. Another question is how absolute the transition from natural vegetation to crop and fallow land is in terms of tree cover. Based on Parkan (1986), it is possible to calculate the standing wood volume per hectare for crop and fallow land in 1980. This amounts to 17 m^3 ha^{-1} compared to 23 m^3 ha^{-1} for natural forest and savanna vegetation, which puts the loss of forest and savanna coverage into a less alarming perspective, because almost 75% of the tree and shrub volume remains, as natural forest and savanna is replaced by cultivated and fallow land (plate VI). It also points at the fact that judging degradation by sheer numbers may be

[63] French sources (see for example Parkan 1986) speak of "formations forestières naturelles" which is not restricted to actual forests and tree savannas but includes all natural woody vegetation. In English sources (see for example FAO 1999), the term forest is usually used in a more restricted sense, meaning forests and tree savannas and excluding shrub savannas. These differences may lead to very different rates of deforestation in terms of the number of hectares per year. Here woody vegetation will be used to refer to forest resources in their broadest (French) sense and the term forest when referring to forest resources in the more narrow (English) sense.

[64] It should be noted that MFP (1993: 22) gives a slightly lower estimate of 105,000 ha year^{-1} between 1980 and 1992.

misleading. We will therefore take a closer look at the micro situation: land use and vegetation developments in the two research villages.

5.3.2 Expansion of agricultural land in the research villages

Due to the variable quality and small scale (1:50,000) of available aerial photographs it is very difficult to make a quantitative assessment of the changing composition of natural and long-term uncultivated land. It is possible, however, to examine the process of expansion of the cultivated area. Table 5.1 shows the transition from natural land (including pastures) to agricultural land (including fallow) between 1955 and the late 1980s and early 1990s for respectively Pentouangou and Samboanli. In 30 to 40 years the amount of land under cultivation and fallow increased with a factor 2 in the densely populated Samboanli and with a factor 5 in the sparsely populated Pentouangou (for details on the village territories and current population densities see section 4.8.1). In other words, in line with the trend observed at the national level, also in the research villages a considerable amount of land has been brought under cultivation over the last 40 years. But, when these figures are combined with those of the growth of the village population it appears that the clearance of natural land may already be slowing down in Samboanli.

Table 5.2 gives the estimated amount of agricultural land per head of the village population for 1955 and the late 1980s and early 1990s. Where Pentouangou, the sparsely populated village (13 inh. km^{-2} in 1996), shows an increasing amount of land used per person, the densely populated Samboanli (50 inh. km^{-2} in 1996) actually shows an intensification of agricultural production since the 1950s in the form of less agricultural land per person. The increase in Pentouangou can be explained by an increased interest in agriculture, not only for direct consumption, but also for selling (chapter 7) in an environment were land is still abundant. The decrease in Samboanli can be explained by the increasing scarcity of cultivable land.

A closer look at the land that was cultivated (including recent fallows) both in 1955 and recently, reveals that in Pentouangou less than 20% of the land that was cultivated in 1955 was also cultivated in 1987 and that in the densely populated Samboanli this is still only 55% (tables C.1 and C.2 in appendix C). Agricultural expansion thus did not take place in the form of an expanding circle of land around the village center, but in the form of

Table 5.1 Proportion of natural and agricultural land in Pentouangou and Samboanli in 1955 and 1987/94

	Pentouangou		Samboanli	
Land use	1955	1987	1955	1994
Natural[a]	97%	86%	71%	35%
Agricultural (cultivated & fallow)	3%	14%	29%	65%

Sources: Tables C.1 and C.2 in appendix C.

Note: For Pentouangou the most recent aerial photographs dated from March 1988, representing the land use of 1987, whereas for Samboanli photos from December 1994 were available.

[a]Land was declared natural if no visible traces of cultivation could be observed on the aerial photographs on the basis of texture, geometric patterns and tint. Natural land thus also includes long-term fallows that have regenerated to "natural" savanna.

Table 5.2 Estimated amount of agricultural land per head in Pentouangou and Samboanli in 1955 and 1987/94

Village	1955	1987	1994
Pentouangou	0.56 ha	1.34 ha	
Samboanli	1.93 ha		1.27 ha

Sources: Land use derived from tables C.1 and C.2 in appendix C; population estimates based on archival documents (REC.36; REC.37), national censuses (INSD 1979, 1989, 1998), and village census.

recycling land, both near and far from the village center. The consequence of this kind of recycling is that suitable land, irrespective of the distance to the village center, is occasionally used for arable farming and pure untouched natural vegetation will be hard to find if not on summits of laterite hills and sacred sites. It also implies that the pressure of population on the land is not concentrated on a single location which helps to prevent excessive degradation.

A look at a close-up of an old and a recent aerial photograph from part of the Samboanli village territory, as displayed in figures 5.1 and 5.2, clearly shows how certain recent fields overlap those of the past, whereas in other cases dense shrub or tree savanna now occupies the fields of 1955.

5.3.3 Dynamic processes of change

Now that the quantitative dimensions of land use changes engendered by the growing population of the research villages has been established, it is important to examine the qualitative consequences. It is for instance worthwhile to note that on the just mentioned aerial photos of Samboanli, displayed in figures 5.1 and 5.2, even in those areas that were cultivated in both 1955 and 1994 (such as parts of the village center) the number of trees has not significantly declined. Unlike in most modern mechanized forms of cultivation, in the Gourmantché farming system trees are not entirely removed from the field upon clearing. Important fruit bearing and medicinal trees are generally spared (chapter 4), which facilitates fallow regeneration and soil fertility maintenance (chapter 6). Other species, and most shrubs are however removed from the field, as well as grasses and herbs. Cultivation thus inevitably leads to changes in the floristic communities on the field, especially as the soil physical and chemical properties, as well as the soil fauna and microbiology are modified under the influence of tillage, crop growth, weeding, and so forth. Once put to fallow the original vegetation will not immediately return. In similar ways livestock browsing and grazing affects the soil and vegetation. An increase in cultivated area, stocking densities, and for instance firewood requirements therefore lead to a slow but steady transformation of the whole biotic landscape.

Farmers are well aware of these processes as the following quotation from an interview with Lamoudi Yonli speaking of an area where he used to cultivate illustrates:[65]

> In the past it was a tree savanna. When we arrived there 35 years ago we cut the trees to establish fields. Where trees had been, shrubs developed. When we left the area

[65] Interview held in Pentouangou on 22 May 1997.

[because some 25 years ago lower rainfall made the superficial wells run dry], other shrub species replaced those that had grown there when we cultivated. Species change in relation to the condition of the soil. That is, species that grow on uncultivated land do not remain once land is brought into culture. Also, those that grow there during cultivation will be replaced by yet others once the field is abandoned.

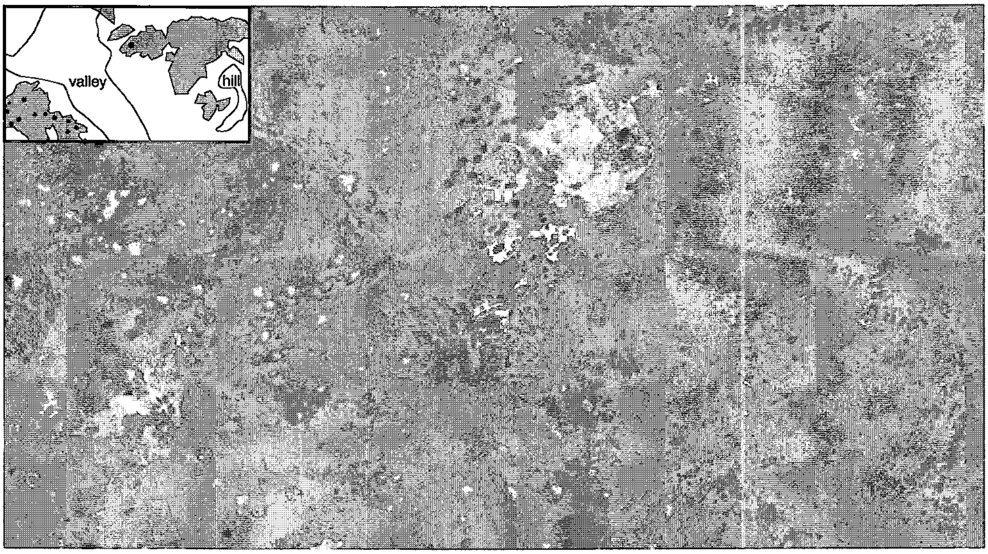

Figure 5.1. Land use in Samboanli in 1955 (same areas as displayed in figure 5.2), with an inset showing fields in gray and compounds in black

Source: Enlargement of a 1:50,000 aerial photograph taken on 29 November 1955, IGN France.

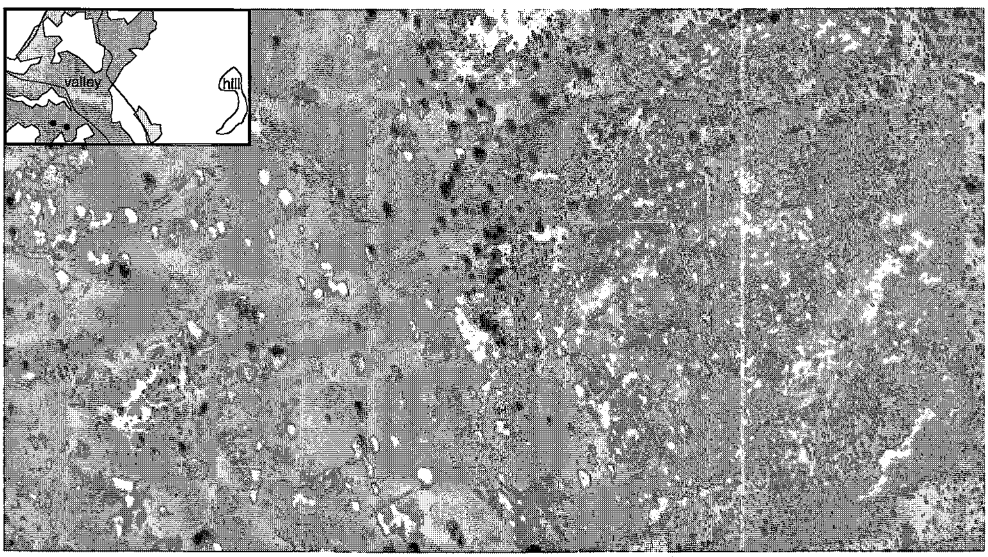

Figure 5.2. Land use in Samboanli in 1994 (same areas as displayed in figure 5.1), with an inset showing fields in gray and compounds in black

Source: Enlargement of a 1:50,000 aerial photograph taken on 16 December 1994, IGB Burkina Faso.

Table 5.3 Appearance and disappearance of plant species in farming zones of Pentouangou and Samboanli

	Pentouangou		Samboanli	
	Appearance	Disappearance	Appearance	Disappearance
Trees	7	8	2	4
Shrubs	3	0	0	1
Herbs/Grasses	4	8	0	5
Total species	*14*	*16*	*2*	*10*

Source: Changing land use study.
Note: For Pentouangou, with its large village territory, interviews were held on 20 of the 22 farming zones (thereby covering most of the village territory). For Samboanli they took place on 7 of the 14 farming zones, thereby covering some 75% of the village territory.

This interview was held as part of a semi-structured survey on the different farming zones in the research villages (see section 3.4.4 for details on this survey). Generally speaking, informants in both villages observed a decline in tree cover, mainly as a result of the droughts of the early 1970s and mid 1980s and the decline in rainfall since the wet 1950s (section 5.4.1). Informants noted that where trees have become less dense, shrubs or grasses have increasingly taken their place. The specific changes depend a lot on the particular area however. In some places grasses have largely disappeared because of livestock grazing, whereas in other areas it is the trees and grasses that remain because the shrubs have been removed for cultivation or firewood. It is thus not possible to give a single direction of change for whole village territories. The kind of changes depend on local physical conditions, as well as on land use developments. In many cases though, informants report that the overall density of the vegetation has declined, mainly because of the persistently drier climate and the drought years.

There have not only been changes in terms of the relative importance of trees, shrubs, herbs, and grasses, but because of the environmental changes (both natural and human-induced), some species have disappeared. Unlike Dupré (1992) noted in the more northern Aribinda area, also quite a number of new species have been observed in the research villages. This was especially so in Pentouangou. Table 5.3 presents an overview of the disappearance and appearance of plant species. From the table it is apparent that in terms of the appearance of new species especially trees are important. These are however mainly "domestic" trees planted in court yards of village or bush compounds, for shade, fruits, or medicinal purposes. For Pentouangou new trees in this category are mango (*Mangifera indica*), eucalyptus (*Eucalyptus camaldulensis*), neem (*Azadirachta indica*), guava (*Psidium guajava*), and lemon trees. For Samboanli these are neem and *Casuarina equisetofolia*, because the informants forgot to mention several of the other trees such as mango and guava.[66] These "domestic" trees will be excluded from further analysis.

Another observation that can be drawn from table 5.3 is that in Samboanli changes were much fewer than in Pentouangou and that aside from the neem and *Casuarina equisetofolia* trees, no new species appeared. This difference between the developments in the two villages can be better understood if we look at the reasons and timing of appearance

[66] This points at the fact that certain species can be so obvious that informants fail to mention them.

and disappearance. Table 5.4 gives this information for Pentouangou. From the table it can be observed that informants see a drier climate and the increasing livestock population as the main sources of floristic change. The factor rainfall became important after the drought in the early 1970s, but has continued to be important as both the mid 1980s and the early 1990s saw a series of dry years (section 5.4.1). The influence of a growing livestock population also has its origin in the 1970s (more on that below).

Table 5.5 gives information on disappearance for Samboanli (appearance was not included because this involves only "domestic" trees). It can be noticed that here climatic change is again the most important factor, while increasing livestock numbers are considerably less important. In this more densely populated village, cutting for clearing land is a relatively important human-induced factor, and the category "other" basically consists of three species that were lost due to flooding caused by a recently established artificial lake near Bilanga that floods the valley all the way up to the outskirts of the Samboanli village territory during the peak of the rainy season.

The relative importance of climatic change in Pentouangou can probably be explained by the fact that Samboanli already had more species adapted to dry conditions as it is located in a more northern, drier area. Also when we look at the influence of livestock, historical developments can help explain the observed differences. In Samboanli livestock has always been present in the form of cattle herded by Fulbe and Rimaïbè who have lived in the area and on the village territory for at least a century. In Pentouangou settlement of Fulbe, on the contrary, is a recent phenomenon that started in the early 1970s, though the majority settled on the village territory around 1985 and later (section 4.8). The role of the coming of cattle to the Pentouangou territory (other than through transhumance) is also

Table 5.4 Reasons for and timing of appearance and disappearance of plant species from farming zones in Pentouangou

Decade	Drier climate	Higher livestock population	Drier climate and higher livestock population	Human-induced (cut/planted)	Other	Total
			Appearance			
1960s						0
1970s	2	2			2	6
1980s	2	1				3
1990s		2		1	1	4
Total	*4*	*5*	*0*	*1*	*3*	*13*
			Disappearance			
1960s					1	1
1970s	3	2	2	1		8
1980s	2		1			3
1990s	3	4				7
Total	*8*	*6*	*3*	*1*	*1*	*19*

Source: Changing land use study.

Note: Each cell gives the sum of the number of species that appeared/disappeared over all zones. A single species that has disappeared from multiple zones for different reasons may thus be counted several times and occur in different cells. Observations regarding the earlier mentioned domestic trees have not been included in the table.

Table 5.5 Reasons for and timing of disappearance of plant species from farming zones in Samboanli

Decade	Drier climate	Higher livestock population	Drier climate and higher livestock population	Human-induced (cut/planted)	Other	Total
1960s	1					1
1970s			2	3		5
1980s						0
1990s	3				3	6
Total	*4*	*0*	*2*	*3*	*3*	*12*

Source: Changing land use study.

Note: Each cell gives the sum of the number of species that disappeared over all zones. A single species that has disappeared from multiple zones for different reasons may thus be counted several times and occur in different cells. Observations regarding the earlier mentioned domestic trees have not been included in the table.

clear from the accounts of informants. Kontondjoa Yonli explains:[68]

> *Nabanli* [shrub, *Piliostigma thonningii*] was brought to this area by the cattle. It grew out of the seeds in their droppings. This species has appeared after the arrival of cattle, when the Fulbe settled in the village some 25 years ago. There are only few plants of this species. After one abandons a field on which *nabanli* grows, seven years later it will die to be replaced by the species that originally grew there, indicating that the soil has regenerated. The plants change from species to species in relation to the time a soil is cultivated.

In other cases livestock played an active role in the disappearance of species as informants explained in a group interview:[69]

> *Moagbandi* [grass, probably *Andropogon ascinodis*] disappeared from this area because of a lack of water. It is a grass that likes to grow where the soil is moist. The second reason is that cattle killed the grass with their hooves, by walking on the grass and by hardening the soil leading the grass to die. It used to be widespread but disappeared in 1985.

What these excerpts from interviews and the enumeration of appeared and disappeared species show, is that the vegetative changes that have taken place in the village territories cannot be described by a simple trend of increasing degradation and loss of biodiversity. Diverse transformations are taking place, whereby, because of changes in the natural conditions and human impact, plant communities are modified leading densities to change and species to appear and disappear. In this context, changes are varied and depend on local circumstances in the villages and different parts of the village territories. In other words, it seems much more appropriate to speak of dynamically changing landscapes (Leach *et al.* 1999), rather than of land degradation, because the later term suggests a uni-

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[68] Interview held in Pentouangou on 21 May 1997.

[69] Interview held in Pentouangou on 20 May 1997.

directional downward trend. The processes and dynamics observed in the research villages are unlikely to be unique, which suggests that, also at the regional and national level, land degradation may be an inappropriate term to describe the transformations that are taking place in the landscape.

5.4 Soil degradation examined at the national level

Up to now the focus has been on the vegetative changes that have taken place during the course of the last 40 to 50 years. This section shifts focus to the soil, in an attempt to answer the question whether soil degradation is as widespread in Burkina Faso as was suggested in section 5.2.1 based on existing sources. We begin, in section 5.4.1, with an analysis of rainfall fluctuations since the 1920s, as an understanding of these is a prerequisite for the discussion on soil degradation at the national level that is the topic of the subsequent sections. The discussion of soil degradation at the national level will be based on examination of two types of evidence: long-term yield trends of the major crops (section 5.4.2) and the impact of population pressure on agricultural productivity (section 5.4.3). The discussion will limit itself to cultivated land as few data are available on rangeland productivity. In a final section (5.4.4), the discrepancies between the evidence provided by these analyses and the estimations of one of the most influential nutrient budget models are discussed.

5.4.1 Rainfall fluctuations

Rainfall is a very important factor in dryland agriculture. However good a soil may be, rainfall can make or break a harvest when the timing is off, or when there is too little or too much of it. Yields in Sahelian countries are indisputably affected by rainfall and any analysis of long-term yield trends thus has to take rainfall trends into account, especially since it has been widely claimed that rainfall has declined over the last 20 to 30 years in the Sahel (see for example Sivakumar 1991; Hoogmoed *et al.* forthcoming). Whether there is indeed such a downward trend in Burkina Faso, and how important it is, is the subject of this section.

As Sivakumar and Gnoumou (1987) pointed out that there is a considerable variation in long-term patterns between individual stations, it is necessary to look at multiple stations to reveal if there is something as a general, nationwide pattern of rainfall decline. For this purpose an average was calculated for the annual rainfall of the 16 major stations in Burkina Faso with a long-term record.[70] The result is shown in figure 5.3, which displays the individual data-points, as well as a trewess trend curve and the long-term average.[71] The graph shows an irregular, cyclical pattern until the mid 1960s, when a steady downward

[70] These are: Banfora, Bobo-Dioulasso, Boromo, Dédougou, Diébougou, Dori, Fada N'Gourma, Gaoua, Houndé, Kaya, Koudougou, Koupéla, Léo,Ouahigouya, Tenkodogo, and Ouagadougou. For Ouagadougou an average was taken of Ouagadougou Aero, Ouagadougou Mission, and Ouagadougou Ville.

[71] The trewess (Trimmed REsistant WEighted Scatterplot Smooth) trend is based on a span of 25% and a trim of 10%, see Velleman (1997) for details on this method.

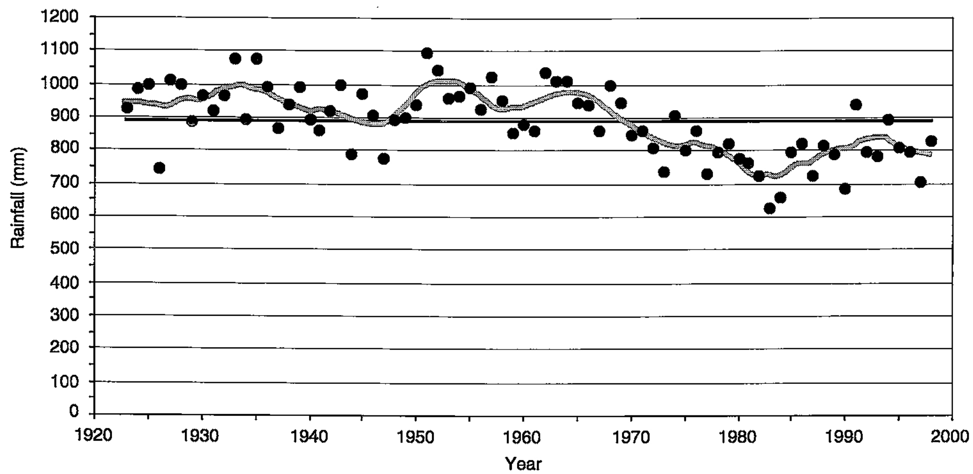

Figure 5.3. Average annual rainfall of 16 major rain stations in Burkina Faso (1923-1998)
Source: Table A.1 in appendix A.

trend develops until the mid 1980s, after which rainfall levels improve a little again, but remain below the long-term average. As a result, average annual rainfall decreased almost 300 mm between the particularly wet early 1950s and the mid 1980s, while even at present it still remains some 200 mm below the amount of the early 1950s. The present evidence is in contrast to Sivakumar and Gnoumou (1987), who examined rainfall records up to 1984 and concluded that there was no evidence of a general decline from normal rainfall since the 1950s. It is difficult, however, to say whether this points to a more permanent decline of rainfall in Burkina Faso, especially as there seems to be some recovery in the late 1980s and early 1990s. It is known from oral histories and, for instance, the works of Arab geographers and other travel accounts that there have been other periods with considerably below average rainfall (Nicholson 1979). The decline we observe at present may thus be a temporary phenomenon. This is not to say that there is no reason for concern. For local farmers and pastoralists the decline in average annual rainfall since the wet 1950s is very real and affects their daily livelihoods significantly. And, as Dennett *et al.* (1985) suggest, it might be better to base agricultural planning on recent rainfall records rather than on the higher long-term averages.

For farmers nationwide trends are of little relevance. What counts for them is the local rainfall pattern. It was already noted that there are large differences between individual stations that may in some cases deviate considerably from the general trend. Figure 5.4 shows long-term rainfall patterns for the national capital Ouagadougou (5.4a), which has the oldest available rainfall records in Burkina Faso, and Fada N'Gourma, the capital of the eastern region (5.4b). Three important observations can be made on the basis of these graphs. Firstly, figure 5.4a shows that, for Ouagadougou, the dip in rainfall of the 1980s is more than matched by a similar dip during the first years of the second decade of the twentieth century (a period not covered by the other stations). This is another piece of evidence against assuming that the current decline in rainfall is permanent. Secondly, the decline in rainfall since the wet 1950s is much more marked for Fada N'Gourma than for

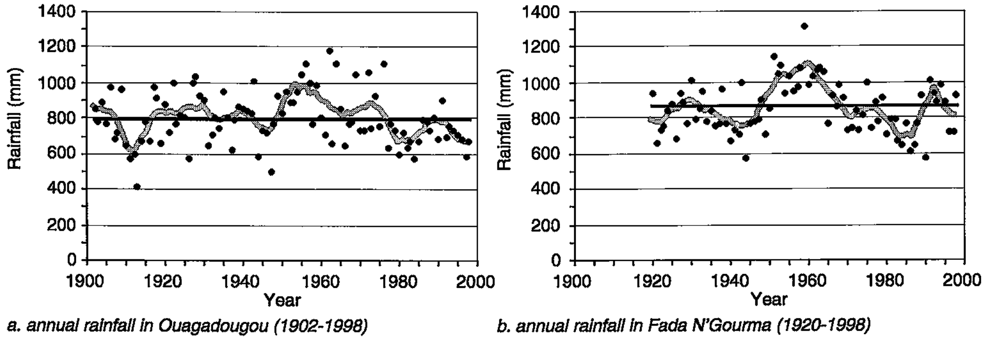

Figure 5.4. Annual rainfall for Ouagadougou (1902-1998) and Fada N'Gourma (1920-1998)
Source: Table A.1 in appendix A.

either Ouagadougou or the 16 stations average displayed in figure 5.3. Finally, Fada N'Gourma shows a more pronounced peek in the early 1990s, than in either of the other graphs. However, also for Fada N'Gourma the average annual rainfall in the 1990s as a whole, is still some 200 mm below that of the wet 1950s. The observed variation between stations is likely to be related to the highly probabilistic nature of rainfall in the Sahel. There is a large spatial and temporal variation in rainfall (that increases as total rainfall decreases), which, with relatively few showers per season, may lead a single shower to significantly influence the total annual rainfall recorded at a station.

The marked decline in rainfall since the particularly wet 1950s may well be the reason that farmers in the eastern region have the impression that rainfall levels are decreasing on a more permanent basis. Few farmers will vividly remember the dry 1940s. Likewise, there is a tendency among development specialists to see a more permanent downward trend for the country as a whole, because the majority of rainfall stations date from the 1950s or later: of the more than 150 rain stations in Burkina Faso only 30 have records that start before 1950 (based on ADDS 1998c).

Given the noticeable decline in average annual rainfall since the wet 1950s, there is sufficient reason to conclude that the earlier mentioned changes observed in savanna and forest vegetation (section 5.3) can indeed be partially attributed to decreasing rainfall levels, as was suggested by our informants and, for instance, MEE (1996). It also implies than any discussion of yield trends should be held against the light of decreasing rainfall levels over the last half a century.

5.4.2 Yield trends

Decreasing yields are often cited as a result of declining rainfall and soil degradation, by farmers, development workers, and researchers alike (e.g., Ramaswamy and Sanders 1992; Powell and Williams 1993). Pieri (1989), however, suggests that the yields of most crops in the Sahelian countries are stable and some may have even been increasing between 1960 and the early 1980s. For Burkina Faso this view is confirmed by Lecaillon and Morrisson (1985). If this alternative analysis is correct, it would be a remarkable feat, given the rainfall decline that was observed in the previous section.

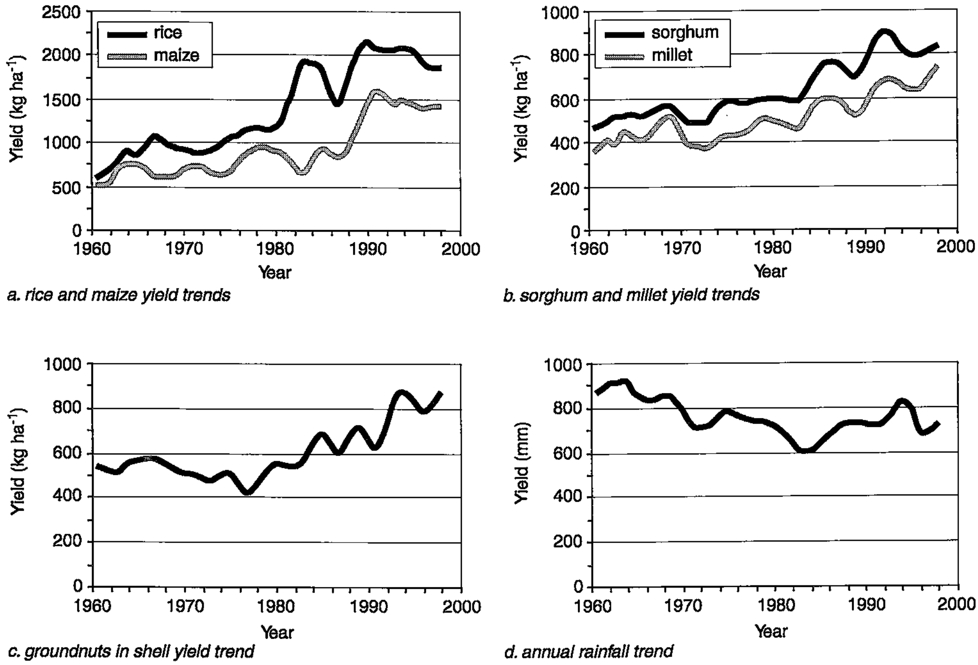

Figure 5.5. Yield trends for Burkina Faso (1961-1998)

Source: Calculations based on data from FAO (2000), ADDS (1998c), and the national meteorological service.

Note: Annual rainfall was calculated as the average of the provincial rainfall levels, determined by averaging the stations within each of the provinces. Trends are displayed using trewess smoothing with a span of 20% and a trim of 10%.

Here, yield trends will be analyzed based on national level data for Burkina Faso for the years 1961 to 1998 derived from the FAOSTAT crop database (FAO 2000).[72] Figure 5.5 displays the yield trends for five major crops that together cover more than 90% of the cultivated area: rice, maize, sorghum, millet, and groundnuts. From the graphs it is evident that, despite a decrease in annual rainfall of some 150 to 200 mm in a little less than 40 years (fig. 5.5d), rice and maize yields increased with a factor 3 (fig. 5.5a) and sorghum, millet and groundnuts with a factor 2 (fig. 5.5b and 5.5c). Still, the more rapid yield increase of the last 15 years, for sorghum, millet, and groundnuts, may be the result of the slight reversal of the downward rainfall trend since the mid 1980s. There are also several dips in the yield trends that generally occur around the time of the 1973, 1984, 1990 and 1997 droughts. An upward spike is recognizable for the unexpectedly wet 1994 year.

The especially strong increase in maize and rice yields may be explained, at least partly, by a modernization of the production process in the form of mechanization, irrigation and an increased input of organic and non-organic fertilizers. Both crops show a major increase since the mid 1970s when, as evidenced by the FAO statistics database (FAO 2000), national fertilizer use began to increase followed by an increase of tractor

[72] These data are based on data supplied by the individual member states. For Burkina Faso they generally match well with the national agricultural statistics published by the Ministry of Agriculture and its predecessors.

usage in the mid 1980s. Another important factor for rice is the establishment of irrigation schemes. For groundnuts, millet, and sorghum, the observed yield increase is more moderate and more steady. As these crops generally receive little fertilizer and their production still remains largely manual, more subtle changes in the production process must explain the yield increase. Such changes include the increased use of animal traction, but this factor alone can hardly explain the whole increase, because at present still only one-fourth of the Burkinabè households own a plow and almost 80% of the plots are manually tilled or not at all (MARA 1996a: tables A53, A104). It is likely that changes in agronomic practices (chapter 6), as well as labor intensification, stimulated by improved marketing possibilities for surplus production (chapter 7), have also made important contributions. But, whatever the causes of the increased productivity per unit area, the data definitely counter any claims of diminishing yields as a proof for soil degradation. There is no evidence for decreasing yields as figure 5.5 clearly demonstrates. As Pieri (1989) and Scoones and Toulmin (1999) point out, this kind of long-term, national level data only has a limited accuracy (as collection procedures change over time and the institutions involved have a stake in the outcome).[72] However, there is no reason to assume, even if yields in the past were to some degree underestimated, that a recorded two- to threefold yield increase would represent an actual yield decrease in the field. What is more, claims of yield decline are usually based on the same kind of data.

It may be concluded that the data presented in figure 5.5 tell a more positive story than the mere absence of a yield decline (or slight improvement) as noted by Lecaillon (1985) and Pieri (1989).[73] This difference can be attributed to the shorter time frame of those studies (1960-1982) compared with the data presented here (1960-1998), which means they are missing the strong yield growth following the mid 1980s.

The yield increase over the past 40 years is even more surprising if we take into consideration the annual rainfall trend.[74] Agricultural productivity per unit area has increased between the early 1960s and the late 1990s, despite a 150 to 200 mm decline in

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[72] Pieri (1989: 85) for instance notes important differences between the national level statistics for Mali provided by the FAO and the Bureau pour le Développement de la Production Agricole (BDPA).

[73] Pieri (1989) also noted a yield increase for millet in Burkina Faso based on data from the BDPA.

[74] Decreasing rainfall levels may however be one of the explanations why both farmers and many outside observers have the impression that yields have declined. With high rainfall levels, such as those recorded in the 1950s and early 1960s, relatively good yields could be attained with comparative ease. Older informants in the research area explain that in those days relatively little effort was spent on crop production (most notably weeding) and that families could still be fed easily. At the time, people were less numerous and surplus production was of little use (for lack of marketing possibilities). This, together with a tendency to idealize the past, may explain why, looking back, yields are said to have been higher in the past. Similarly, human psychology may also be able to explain the impression that today's yields are low. At present, farmers put a lot of efforts in crop production, but due to the decreased rainfall levels and the associated increase in spatial and temporal rainfall variability, the risk of total crop failure for individual farmers may well have increased, while repercussions of bad years can be enormous. High risks of crop failure despite great efforts might be one of the reasons that farmers have the impression that today's yields are lower than those of the past. Also, because more people need to be fed and because there are ready outlets for surplus production, farmers want to produce more grain nowadays. Finally, the experiences of outside observers tend to be biased by a focus on crisis areas and crisis situation (i.e., when yields are below average), because when everything goes well there is much less demand for their services.

rainfall, giving even less of a reason to suppose soil degradation based on yield statistics. Also in light of strong population growth (between 1961 and 1996 the resident population of Burkina Faso grew from 4.6 million to 10.3 million, Haute-Volta 1970; INSD 1998) the yield increase is remarkable and provides little evidence for a Neo-Malthusian style doom-scenario of overpopulation leading to land degradation and eventually starvation. Figure 5.6a shows that annual cereal production per capita has actually risen considerably over the past 40 years, implying that improved yields and larger cultivated areas have actually been able to keep pace with population growth.[75] Based on an estimated average cereal requirement of 190 kg capita^{-1} year^{-1} (MARA 1997b), we see that after a low from the early 1970s to the mid 1980s domestic cereal production again more than meets the needs of the population. This, as can also be seen in figure 5.6a, has been due to a considerably increased labor productivity (expressed as the annual cereal production per agriculturally active person). Especially after the 1984 drought, an important increase in labor productivity can be observed that runs more or less parallel to the earlier observed yield increases. From figure 5.6b it can be deduced that this recent labor productivity increase was in part achieved through a temporary augmentation of the amount of land harvested per agriculturally active person, after this had steadily declined between the mid 1960s and 1984. In other words, an increase in yields and harvested areas have together led to a production level that has been able to meet the needs of a growing population over the last 10 to 15 years.

It is difficult to determine what exactly triggered the increased land and labor productivity starting in the mid 1980s. One possibility is that this is an artifact of a changed registration system. It is a fact that the way agricultural statistics were collected improved after 1990,[76] but it is unclear how this relates to the changes observed around 1985. If the productivity increase is indeed an artifact it would suggest underestimation of agricultural productivity and thus production per capita for the earlier period. Another possibility is that in response to the 1984 drought farmers tried to avert the risk of crop failure by sowing more land, which when rainfall increased again, led to a substantial increase in production because the larger sown area not only produced, but also yields returned to pre-drought levels. The fact that such a sudden break in the general downward trend of harvested area per agriculturally active person is also visible (in figure 5.6b) following the 1973 and 1990 droughts gives credit to this explanation.

But, figure 5.6b has an even more important story to tell. It shows that the amount of cereal land cultivated per individual has steadily decreased over the last 40 years, from some 0.75 ha to around 0.6 ha per person.[77] As yields, production, and labor productivity have risen during that same period this points at an intensification of agriculture. In other words, a kind of Boserupian scenario may actually be taking place, whereby population

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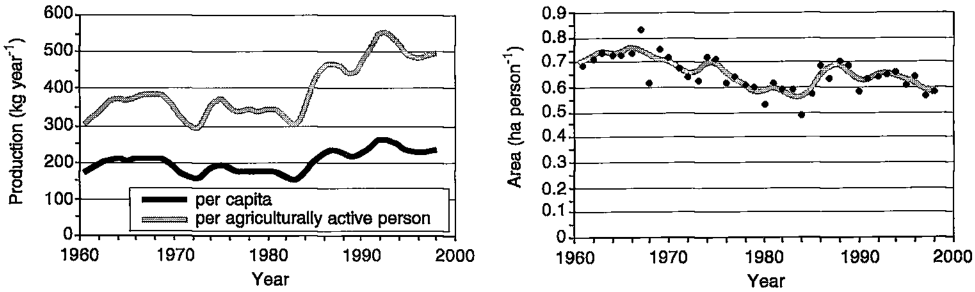
[75] Cereals make up some 90% of the total cultivated area in Burkina Faso.

[76] Before 1990, every office of the regional extension service had its own methodology to collect these figures (Jan Piet van der Mijl, personal communication). Since 1993 a stratified random sample is used in which yields are based on crop-cuttings and plots are measured for selected households in 500 villages throughout the country (see section 3.3.1 for details). Before 1990 the agricultural extension officers were asked for their personal estimates of the cultivated area and the yields.

[77] The ratio cereals and other crops stayed more or less constant over this period.



a. annual cereal production *b. harvested cereal area per agriculturally active person*

Figure 5.6. Annual cereal production per capita, agricultural labor productivity, and harvested cereal area per agriculturally active person

Source: Calculations based on data from FAO (2000).

Note: Trends are displayed using trewess smoothing with a span of 20% and a trim of 10%.

increase creates an impetus for agricultural intensification. This raises two important questions. How does population growth create an impetus for agricultural intensification in Burkina Faso and what form does this intensification take? The latter question is very important as there are few signs of a classic path of intensification through privatization of land, increased use of mineral fertilizers, and mechanization of agriculture. These questions will be the topic of the upcoming chapters.

In sum, it may be concluded that the observed increase in both land and labor productivity over the last 40 years does not provide any evidence of widespread soil degradation in Burkina Faso. To the contrary, a process of agricultural intensification seems to be taking place. In the next section a closer look will be taken at the factors influencing agricultural production. In a spatial analogy of this section's temporal analysis, the next section will investigate the role of population density on agricultural productivity in present-day Burkina Faso.

5.4.3 Pressure on natural resources and soil degradation

Based on the theories of Malthus and Boserup that were discussed in chapter 2, a correlation may be expected between population density and soil degradation. Burkina Faso, though one of the smallest West Sahelian countries, has one of the largest rural populations of the region. The estimated rural population density for 1998 is 34 inh. km^{-2} (FAO 2000), but rural population densities vary considerably from province to province, with the lowest, 12 inh. km^{-2}, in Gourma province and the highest, 84 inh. km^{-2}, in Kouritenga province (for 1993, calculation based on MARA 1996a, 1998b; ADDS 1998a).[78] In other words, Burkina Faso presents an ideal case to see the effect of population density on soil degradation.

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[78] In this chapter frequent use is made of data from a 1993 national agricultural survey (MARA 1996a) for the rural population figures per province. Strictly speaking this survey refers to the agricultural population and not to the rural population, but as the survey report states, these two are very close.

As nationwide soil fertility measurements for Burkina Faso are absent, soil degradation will be operationalized in terms of a decline in agricultural productivity. The primary focus will be on agricultural productivity per unit cultivated area as this most directly relates to the condition of the soil. Agricultural labor productivity (cropping only) will however also be considered, as it can also be expected to be negatively affected by soil degradation. The key question will be whether there is a correlation between population density and agricultural productivity that could be a sign of land degradation.

The considered factors

The analysis will compare the agricultural productivity of Burkina Faso's 30 provinces looking at the following factors: pressure on natural resources, technology usage, and environmental conditions.[79] For pressure on natural resources the following proxies were used: area cultivated per agriculturally active person, rural population density, percentage of provincial area used for cultivation, and livestock density (the latter three based on the unprotected areas).

For technology usage the following proxies were investigated: proportion of tilled plots plowed with animal traction, plow ownership per agriculturally active person and per hectare cultivated, amount of NPK and urea fertilizer used per agriculturally active person and per hectare cultivated, amount of livestock per rural capita (as a source of manure),[80] proportion of plots treated with anti-erosive structures, proportion of household heads receiving agricultural extension services (training), proportion of household heads who received this extension from the national extension service.

For the environmental conditions long-term average rainfall was used as a proxy because in the Sudanian and Sahelian zone the rainfall regime is strongly associated with other climatic characteristics as well as the general potential of the soils. Bationo *et al.* (1998), for example, show that soil fertility in West Africa is strongly related to the rainfall regime. At the same time rainfall is one of the most important aspects of the environment influencing crop growth.

Finally, total annual agricultural production of food crops per cultivated area and total annual agricultural production of food crops per agriculturally active person were used as measures of the productivity of land and labor respectively. Production for all major food crops was combined into a total production figure per province by converting the production for each crop to its energetic value. Cotton was the only major crop that was excluded from the main analysis because it receives important quantities of fertilizer and therefore does not give a good indication of the "natural" productivity of the land. To verify whether the inclusion of cotton would lead to different results an alternative analysis was done on the basis of conversion of production figures to dry production,[81] thus permitting the incorporation of cotton.

[79] All available statistics are based on the pre-1996 administrative division based on 30 provinces.

[80] The amount of livestock per rural capita is, of course, only a very rough indicator of manure availability as only a part of the herds are kept on-farm while a variable proportion leaves on transhumance during part of the year.

[81] The term dry production refers to the dry harvested grains or roots (i.e., not to total dry matter production).

Table 5.6 Factors included in the analysis of the relation between pressure on resources and agricultural productivity

Factor	Proxy/Variable	Unit	Transformation[a]
	Agricultural Productivity (dependent variable)		
Land productivity	Energy production of food crops per hectare	GJ ha^{-1}	none
	Dry production per hectare	Mg ha^{-1}	none
Labor productivity	Energy production of food crops per agriculturally active person	GJ $head^{-1}$	log
	Dry production per agriculturally active person	Mg $head^{-1}$	log
	Pressure on natural resources (independent variable)		
Population density	Rural population density on unprotected areas	inh. km^{-2}	log
Livestock density	Livestock density in TLUs on unprotected areas	TLU km^{-2}	log
Proportion of area under cultivation	Percentage of unprotected provincial area under cultivation	%	none
Area cultivated per head	Hectares cultivated with food crop per agriculturally active person cultivating food crops	ha $head^{-1}$	log
	Total hectares cultivated per agriculturally active person	ha $head^{-1}$	log
	Technology (independent variable)		
Animal traction index	Proportion of tilled plots tilled with animal traction/ proportion of tilled plots tilled manually		log
Plow usage	Total plows per cultivated hectare	plows ha^{-1}	log
	Total plows per agriculturally active person	plows $head^{-1}$	log
	Ox plows per cultivated hectare	ox plows ha^{-1}	log
	Ox plows per agriculturally active person	ox plows $head^{-1}$	log
	Donkey plows per cultivated hectare	donkey plows ha^{-1}	log
	Donkey plows per agriculturally active person	donkey plows $head^{-1}$	log
Fertilizer usage	NPK per cultivated hectare	kg ha^{-1}	log
	NPK per agriculturally active person	kg $head^{-1}$	log
	Urea per cultivated hectare	kg ha^{-1}	log
	Urea per agriculturally active person	kg $head^{-1}$	log
Manure usage	Livestock density in TLUs on unprotected areas	TLU km^{-2}	log
	TLUs per rural capita[b]	TLU $head^{-1}$	log
Soil and water conservation	Percentage of plots with anti-erosive measures	%	none
Agricultural extension	Percentage of household heads receiving extension	%	none
	Percentage of household heads receiving extension from the national extension service	%	none
	Environment (independent variable)		
Climate	Long-term average annual rainfall (1956-1998)	mm	none

[a]Logarithmic transformations were applied prior to statistical analysis for amounts (measurements that cannot be negative) and counted fractions (such as percentages) in those case where this improved normality of the distribution.

[b]TLUs per rural capita were used instead of per agriculturally active person, because, unlike, for instance, plows, livestock is also owned and used by people who are not agriculturally active.

All data were for the mid 1990s, while production statistics were averaged over 5 years to compensate for the effects of year to year differences in rainfall amount and distribution, on cultivated areas and yields.

Table 5.6 presents an overview of the factors and proxies used in the analysis. Details on the data sources used and on the computations involved in calculating the mentioned proxies are given in section 3.3.1 of the methodology chapter, while table A.2 in appendix A gives the raw numbers that were used as a basis for the analysis.

Forestry or livestock production were not taken into account in the calculation of the agricultural productivity as these are difficult to incorporate and our focus was on the productivity of cultivated land, not that of fallow or bush land. This of course implies that while the northern, low rainfall parts of the country show a relatively low energetic value for the total agricultural crop production, this does not necessarily imply that people have less energy available for consumption. They may well consume more livestock products than in other parts of the country, or sell livestock to buy grain from elsewhere. Similarly, people in the southern, high rainfall parts of the country may not consume all of their agricultural produce. In other words, our calculations provide insight in the arable productivity of cultivated land and do not necessarily provide insights on food security.

Agricultural productivity per unit area

Figure 5.7 shows 4 maps of Burkina Faso displaying agricultural productivity per unit area (5.7a) as well as proxies for the three main determining factors: environmental conditions (5.7b, long-term average annual rainfall), pressure on natural resources (5.7c, rural population density), technology usage (5.7d, animal traction index). From these maps it is immediately apparent that the pattern for agricultural productivity per unit cultivated area is much more similar to that of annual rainfall than either rural population density or the animal traction index. An analysis of the Pearson Product-Moment correlation for the variables that were given in table 5.6 confirms this observation (see table A.3 in appendix A for a partial correlation matrix). Of all examined variables long-term average annual rainfall has the highest correlation (.9) with productivity per unit area, while for instance rural population density (smaller then -.1) is practically negligible. From the maps it also appears that those provinces whose productivity seems to over or under-perform in relation to their average rainfall levels show respectively a higher or lower animal traction index.

To explore the relationship between agricultural productivity and the factors listed in table 5.6 in a more quantitative way, several stepwise linear regressions were performed. The results of the first stepwise regression in terms of increasing R^2 are given in table 5.7 (see tables A.4 and A.5 in appendix A for the full final regression tables and levels of significance). These analyses reveal that agricultural productivity per unit area can be explained for over 85% by the following three variables (in order of importance): (1) long-term average annual rainfall, (2) animal traction index, and (3) proportion of area under cultivation. The difference between energy production and dry production is minimal. The fact that rainfall contributes over 80% of the explained variance (see table 5.7) implies that environmental conditions are by far the most determining factor in crop production. Productivity is (at present) only to some degree influenced by technology of which the

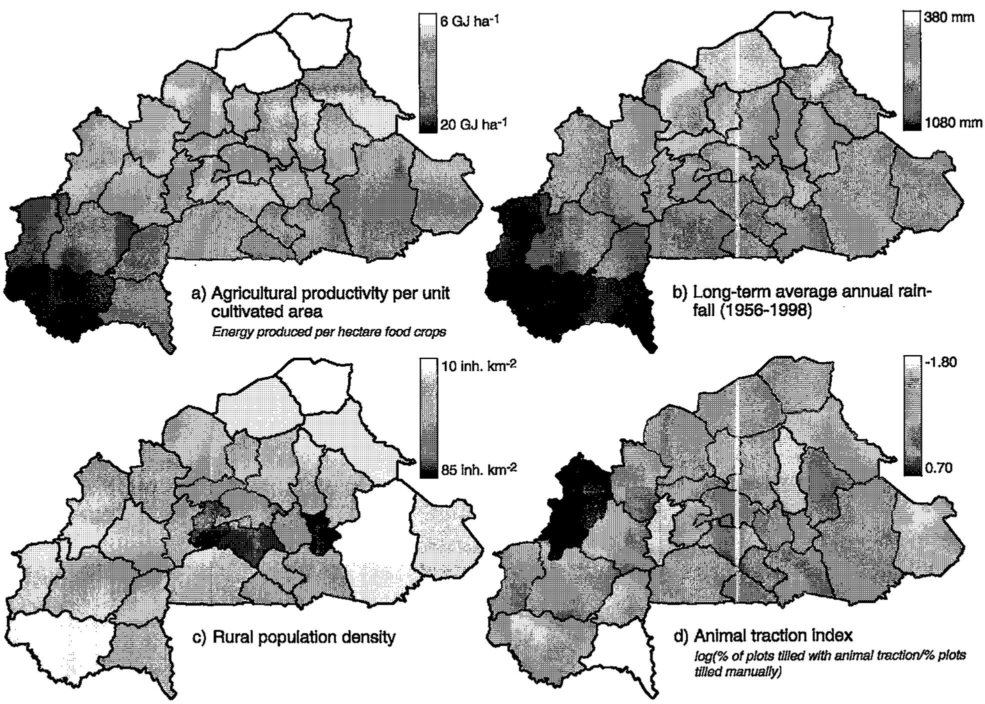

Figure 5.7. Maps of Burkina Faso depicting: a) agricultural productivity per unit cultivated area; b) long-term annual rainfall; c) rural population density; d) animal traction index
Source: Calculations based on table A.2 in appendix A.

animal traction index appears to be a useful proxy. This is in agreement with Savadogo *et al.* (1998: 461), who, based on a large-scale household survey that took place in Burkina Faso between 1981 and 1985, found evidence that "animal traction greatly improves land and labor productivity".

After the effects of the environment and technology have been accounted for, the proportion of area under cultivation also turns out to be significant. The fact that this variable has a negative coefficient (see tables A.4 and A.5 in appendix A), indicates that productivity decreases with an increase in the cultivated proportion of the provincial areas. This effect can most likely be attributed to the fact that, as the area under cultivation increases, some marginal soils are taken into production depressing the average productivity of the soils under cultivation. A decline of the average productivity of the soils under cultivation does not necessarily imply a decline in actual soil fertility of the individual soils, just a lower average soil fertility as the area under cultivation is extended to more marginal soils.[82] Had an actual decline in soil fertility taken place because of

[82] This does not necessarily mean that the best soils are always cultivated first and that with every extension of the cultivated area more and more marginal soils are brought into production. It only implies that, especially in the more densely populated provinces, newly cultivated soils may on average be more marginal than those that were taken into production earlier.

Table 5.7 Stepwise regression of energy and dry production per hectare

Order[a]	Variable	Energy production per hectare		Dry production per hectare	
		R^2 (%)	R^2 (adjusted)[b] (%)	R^2 (%)	R^2 (adjusted)[b] (%)
1	Rainfall 1956-1998	81.2	80.6	81.2	80.5
2	Animal traction index	84.0	82.8	83.9	82.7
3	Proportion of area under cultivation	88.1	86.7	87.3	85.8

Source: Stepwise regression analysis. Full final regression tables are given in tables A.4 and A.5 in appendix A.

Note: Variables were added to the regression equation if significant correlations existed between the residuals of the prior variables and any of the other variables in the pool (see table 5.6). The table shows how R^2 increases with each addition of a new variable. The process of adding variables stopped if none of the remaining variables had a significant relationship with the residuals.

[a]This column gives the order in which variables were added to the regression.

[b]This column gives the R^2 adjusted for the degrees of freedom.

pressure on resources one would expect rural population density and/or livestock density to be more significant than the proportion of area under cultivation.

The results of this regression differ from those found by Cleaver and Schreiber (1994) who did a similar kind of exercise for all of sub-Saharan Africa, but with countries as cases and limited to cereal yields only. They found that with a decrease of the cultivated area per person, cereal yields significantly increased, a fact that was attributed to intensification of production (albeit at a rate of only one-third of population growth). For the provincial data from Burkina Faso no such relation was found.

Agricultural productivity per unit labor

Also for agricultural labor productivity, stepwise linear regressions were done. The results are given in table 5.8, which shows the stepwise increase of the R^2 (see tables A.7 and A.8 in appendix A for details on the final regression). In this regression 90% to 92% (for dry production and energy production respectively) of the variance could be explained by the following variables (in order of importance): (1) long-term average annual rainfall, (2) area cultivated per head, (3) animal traction index, and, for energy production only, (4) proportion of area under cultivation. These are the same factors that were found for land productivity except for area cultivated per head. This variable lends its importance to the fact that production is a function of both yield and land. In other words, the more land is cultivated per person the higher the total production per person. Together, rainfall and area cultivated per head explain 89% of the total variance (see table 5.8). Where for energy production the next factor, the animal traction index, is highly significant, it is somewhat less so for dry production. The proportion of the area under cultivation is no longer significant for dry production and only just significant for energy production.

Table 5.8 Stepwise regression of energy and dry production per agriculturally active person

Order[a]	Variable	Energy production per agriculturally active person (corrected for cotton area) R^2 (%)	R^2 (adjusted)[b] (%)	Dry production per agriculturally active person R^2 (%)	R^2 (adjusted)[b] (%)
1	Rainfall 1956-1998	34.9	32.6	33.5	31.2
2	Area cultivated per head	90.0	89.3	89.7	89.0
3	Animal traction index	92.2	91.3	91.9	90.9
4	Proportion of area under cultivation	93.2	92.1	n.s.[c]	n.s.[c]

Source: Stepwise regression analysis of which the full final regression table is given in tables A.7 and A.8 in appendix A.
Note: Variables were added to the regression equation if significant correlations existed between the residuals of the prior variables and any of the other variables in the pool (see table 5.6). The table shows how R^2 increases with each addition of a new variable. The process of adding variables stopped if none of the remaining variables had a significant relationship with the residuals.
[a]This column gives the order in which variables were added to the regression.
[b]This column gives the R^2 adjusted for the degrees of freedom.
[c]n.s. = not significant.

Discussion

Several conclusions may be drawn based on the regressions for land and labor productivity. Differences in environmental conditions are by far the most important explanation for the observed differences in land and labor productivity.[83] Technology, in the form of animal traction, plays a minor role in determining productivity levels. This suggests that at the present state of technology usage in Burkina Faso, environmental conditions, more than anything else, determine production. In other words, at the province level environmental conditions appear to be the most important production limiting factor. At the same time there is no indication whatsoever that pressure on resources in the form of rural population density or livestock density affects the productivity of the land. As such, the spatial analysis of the agricultural productivity of cultivated land does not provide any evidence of soil degradation as a result of pressure on soil resources. In turn, this implies that a neo-Malthusian doomsday scenario of population pressure leading to soil degradation at present does not seem to be taking place in Burkina Faso. Neither do these findings provide any evidence of soil improvement above a certain population density that could imply a Boserupian breaking point above which population density incites land improvement (chapter 2).

At first sight there thus does not seem to be any reason for concern as the increasing population densities have not led to degradation of cultivated soils. Looking at the maps in figure 5.8 reveals that there may be reason for some concern, not for the soils, but for the nutrition of the population. Comparing figure 5.8a with figure 5.7a reveals that in the

[83] The fact that long-term average rainfall has such a high correlation (and significance) for the variation in land and labor productivity does not necessarily imply that water rather than nutrients are limiting to crop growth. As was mentioned earlier, rainfall is not only a proxy for water availability, but also for other environmental conditions such as soil and soil fertility.

northern provinces the per unit labor productivity is better than one would expect based on per unit land productivity. As figure 5.8b shows this can be explained by the fact that in the northern provinces low yields are partly compensated for by cultivating larger areas per person. Adding to that the fact that livestock is a major source of livelihood in those provinces this compensation seems to be adequate. In contrast, as can be seen in figure 5.8b, the Central Plateau may be characterized by relatively small cultivated areas per agriculturally active person, which leads to a relatively lower productivity per unit labor (figure 5.8a) than would be expected based on the productivity per unit land of this part of the country (figure 5.7a). Comparing figures 5.8b and 5.8c reveals that the small amount of land cultivated per agriculturally active person on the Central Plateau is directly related to the proportion of the total unprotected provincial area under cultivation. In other words, land has become a scarce resource in this part of the country, forcing people to cultivate less land than in most other parts of the country. As a consequence, energy production per capita and per rural capita, displayed respectively in figures 5.8d and 5.8e, is lagging behind compared to other areas at the same latitude.

Considering that the average daily energy requirement per capita for Burkina Faso is 8,577 KJ (2,050 kcal caput^{-1} day^{-1}, James and Schofield 1990: 31), an average 3.1 GJ per capita are annually required to feed the population. In terms of their total crop production (i.e., ignoring storage losses and seed requirements) the provinces on the Central Plateau are not much above this limit, while most other provinces at that latitude keep a safe margin

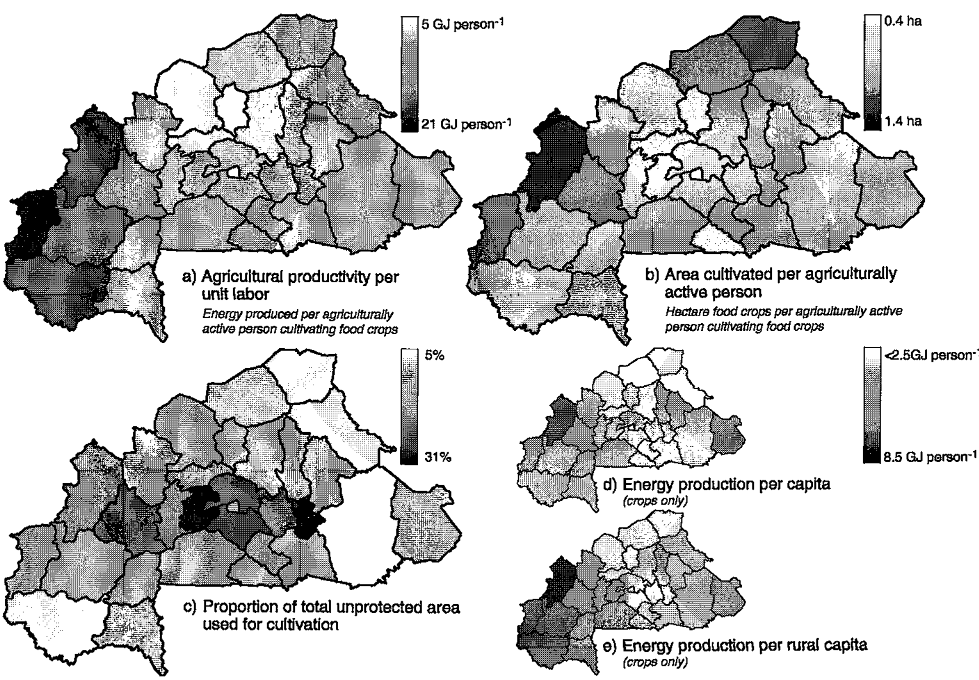

Figure 5.8. Maps of Burkina Faso depicting: a) agricultural productivity per unit labor; b) area cultivated per agriculturally active person; c) proportion of total unprotected area used for cultivation; d) energy production per capita; e) energy production per rural capita

Source: Calculations based on table A.2 in appendix A.

of one or more Giga Joules per capita depending on whether one considers the total population (figure 5.8d) or the rural population (figure 5.8e). The question is whether, as space becomes more and more tight on the Central Plateau, farmers will be able to continue to improve their yields or otherwise gain sufficient energy (i.e., income) from outside the agriculture sector. Increasing population densities thus are a problem, not because the productivity of the soil declines, but because space is running out. However, it must be noted that the population on the Central Plateau has also found ways to gain a livelihood outside their villages, through job opportunities in the capital Ouagadougou, migration to the coastal countries (Breusers 1999), and migration to less densely populated parts of the country, such as the eastern region (INSD 1994). At the same time, it was already observed, as part of the temporal analysis in section 5.4.2, that processes of intensification are currently taking place, i.e., in advance of land degradation and widespread food shortages. This may be considered as a positive indication for the potential to continue improving productivity without causing land degradation.

5.4.4 Evidence of soil degradation versus nutrient budget results

Based on the available data no evidence was found of widespread land degradation on cultivated land, thereby disqualifying the commonly heard claim that yields are declining because of population growth induced soil degradation (e.g., Ramaswamy and Sanders 1992; Bationo *et al.* 1998). Given the spatial scale at which the temporal and spatial analyses were carried out, it is important to realize though, that the presented evidence does not preclude the existence of localized spots of severe degradation of agricultural land. In addition, it should also be kept in mind that the analysis was restricted to cultivated land and as such did not provide any information on the current state of non-cultivated land. However, several recent remote sensing studies (Nicholson *et al.* 1998; Prince *et al.* 1998) concluded that irrespective of land use type, there is no evidence of a gradual deterioration of the vegetative cover in Burkina Faso. This could be an indication that also pastures and bush land are not suffering from a permanent productivity decline, but just responding to the oscillations of rainfall.

There is thus considerable evidence that the situation in Burkina Faso may not be as bad as, for instance, Stoorvogel and Smaling (1990) suggested in the form of the nutrient depletion figures they estimated (annual losses for 1983: 12 kg ha^{-1} K_2O, 14 kg ha^{-1} N, and 4 kg ha^{-1} P_2O_5). In fact, several limitations of this (and other) nutrient budget models may be pointed out that could explain the difference between calculated nutrient deficits and the patterns discussed in the previous sections. It was already mentioned, in section 5.2.2, that nutrient budget models not only depend on unproven up-scaling of experimental results and extrapolation to areas for which the measurements were not taken, but are also very sensitive to some of these factors as was demonstrated for the factor erosion (section 5.2.2).

Stoorvogel and Smaling (1990) are well aware of some of these limitations of their model, which they discuss in an evaluation at the end of their report. They note the sensitivity of the model to soil fertility class and erosion, as well as the many approximations and interpolations that had to be made to provide input data and parameters on all factors for each of the Land Use Systems (LUS's) defined per country. They also note that for the year 2000 scenario no amendments were made to the LUS's thereby ignoring any possible improvements in management practices (though they remark that the model is not very sensitive to management level). It is further noted that nutrient stocks are considered constant and that no changes are accounted for between 1983 and 2000. Most casual readers of the report, and certainly those reading about the results elsewhere, are bound to miss these important points, especially because the consequences of these limitations for the validity of the results are not particularly emphasized in the report.[84] Scoones and Toulmin (1998) observe that in general, nutrient budget studies tend to give too little attention to this aspect. A positive exception is perhaps Krogh (1997a: 157) who ends his "results and discussion" section with the following disclaimer: "Although a widely used method, combining data from different sources means that the balances can be considered no more than rough estimates.... It should be stressed that both input and output values, as well as bottom line values, of the balances are uncertain and must not be interpreted rigorously."

Below, some of the shortcomings of the Stoorvogel and Smaling (1990) model, subsequently referred to as "the model", are discussed in more detail. There are two reasons to focus on this particular model. Firstly, it is at present the only published model available for Burkina Faso.[85] Secondly, it is the single most influential nutrient budget model in the policy debate on soil fertility management in Africa (Scoones and Toulmin 1999).

Aside from the already mentioned aspects, the results of the model are also influenced by the agricultural statistics that were used as inputs. The model is very sensitive to this factor, as for the 1983 scenario, crop production and crop residue removal account for 29 to 58% of annual nutrient losses at the national level, depending on the considered nutrient. Stoorvogel and Smaling (1990) do not take this factor into account in their sensitivity analysis nor is the quality of the data discussed in detail (perhaps because they were derived from the FAO, the initiator of the study). For that reason, this issue will be discussed here for the case of Burkina Faso.

The calculations for the 1983 scenario are based on cropped areas and yields for a wide range of crops split into six FAO Land/Water Classes. In the biannual report of the Ministry of Agriculture (MAE 1984) that covers 1983, data is however only presented per ORD (a division of the country in eleven Organismes Régional de Développement) and information on for instance the areas used for rice and groundnuts is altogether missing for, for example, the eastern ORD (corresponds to Burkina Faso's eastern region), while data for cowpeas is not given at all. The annual report (ORD de l'Est 1984) of the eastern ORD itself neatly splits the production figures and yields into 8 geographical sub-divisions. Yield data (appropriately called estimates in the report) are, however, only provided for sorghum, millet, maize, and rice. All minor crops are missing, including the not so minor pulses and

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[84] Smaling *et al.* (1993), who focus on the district level, give considerably more attention to the limitations of calculating nutrient balances at a continental scale.

[85] With the exception of an unpublished preliminary report by van der Pol and Autissier (1997), which reports nutrient deficits for Burkina Faso of 30 kg N ha^{-1} $year^{-1}$, 1.8 kg P ha^{-1} $year^{-1}$, and 24 kg K ha^{-1} $year^{-1}$ for cultivated fields of the main crops. Excluding phosphorus, these figures are higher than those of Stoorvogel and Smaling (1990). This difference can at least partly be attributed to the fact that the latter report also included fallow land in its calculations.

groundnuts. Cultivated areas are not given but can be calculated (more or less) from the yield data and the production figures. Production figures (estimates again) are limited to the same four crops, while the production of millet and sorghum is combined into a single figure. If, for 1983, the annual report of the eastern ORD (that covers 18% of Burkina Faso's territory) does not contain anything more than estimates, and only for the four major crops, it is doubtful that the figures for the different land use systems from the FAO database that were used as inputs for the model are anything but estimates, and sometimes very crude ones at that.[86]

Another problem with the 1983 scenario is that data from a single year are used. To say something about the impact of agriculture on long-term processes such as soil nutrient depletion the yearly fluctuations in cultivated area and yields should be taken into account. In semi-arid areas such fluctuations can be considerable. Table 5.9 shows just how important these differences are for some of the most important crops in Burkina Faso. It may be hypothesized that if the data for the 1979-1987 mean (a 9-year mean around 1983) would have been used, instead of the 1983 data, very different results would have been obtained in terms of nutrient depletion. In order to test this hypothesis the model was reconstructed in a spreadsheet (see table A.9 in appendix A for an assessment of the accuracy of this reconstruction) and 1983 areas and yields were adjusted based on the 1979-1987 means (only) for the crops shown in table 5.9. Two simplifications were made: (1) the same adjustment factor was applied for each LUS; and (2) the total amount of arable land (cultivated + fallow) was assumed to remain the same. This substitution of input data showed a considerable increase of nutrient losses, as for the year 1983 the cultivated areas and crop yields had been on the low side: nitrogen losses increased 6%, potassium losses 8%, and phosphorus losses a whopping 14%. This clearly illustrates the importance of area and yield inputs.

There is yet another problem with the agricultural input data that was used for the 1983 scenario. First of all, the cultivated area for pulses used for Burkina Faso is a factor 10 higher than the official FAO statistics (FAO 2000) for 1983: 470,000 ha instead of 47,000 ha (which suggests a data-entry error in the model). The high figure used in the model would suggest that more than 15% of the cultivated area in Burkina Faso is used for pulses (as a primary or pure crop) which is highly improbable (it should be around 1.5% of the cultivated area as can be calculated from the national agricultural statistics that were used in section 5.4.3). Correcting this error using the spreadsheet reconstruction of the model, reduces the national deficits by 11 to 12% depending on the considered nutrient. But even the 47,000 ha given in the FAO database is little more than an educated guess if we consider that the FAO database gives a consistent 20,000 ha for cowpeas for all years between 1979 and 1985 and a cowpea yield of 1000 kg/ha for all years between 1969 and 1984. Farmers would wish their environment would allow for such stability! In other words, there is a serious reliability problem where the data that were used in the model for minor crops is concerned. More importantly the model completely ignores intercropping, a

[86] As was already noted, in recent years the quality of the agricultural statistics in Burkina Faso has improved, but regular administrative reforms make it difficult to combine data from different periods or split them up into sub-province units.

Table 5.9 Cultivated areas and yields in 1983 as a fraction of the 1979-1987 mean for Burkina Faso

Crop	Cultivated area	Yield
Groundnuts in shell	0.85	1.05
Maize	0.91	0.69
Millet	1.01	0.82
Rice Paddy	0.77	1.23
Sorghum	0.99	0.88

Source: FAO on-line agricultural statistics database (FAO 2000).

practice that is widespread in countries such as Burkina Faso. For cowpeas, one of the major pulses, for example, more than 95% of the national production is derived from cowpeas as an intercrop, mainly in millet and sorghum fields (calculation for 1996 based on MARA 1997b: tables 30-33). This leads to a higher production per hectare, improved N-fixation, and a decreased erosion due to better groundcover, none of which are taken into account by the model because it assumes monocrops. Thereby it ignores one of the prime characteristics of agriculture in Burkina Faso and many of the neighboring countries.

Another important conceptual problem is that, as was already mentioned, nutrient stocks are considered constant while the yield projections used for 2000 are across the bench higher than the 1983 yields. Stoorvogel and Smaling (1990: 125) note: "The projected yields for the year 2000 are nevertheless higher in all cases, even those with a stable fertilizer consumption and a high nutrient depletion. In such cases, the yields are probably overestimated." As this is the situation for most crops on most LUS's for Burkina Faso's year 2000 scenario, this scenario is dubious to say the least. It highlights the problem of trying to model long-term effects within an inherently dynamic system based on short-term data and a static modeling approach (Scoones and Toulmin 1998). Negative feedback mechanisms, such as the decline of crop production and reduced erosion losses as a result of soil nutrient depletion, leading to a reduction of further losses, as well as a stimulus for farmers to adapt their management, are not covered at all.

That this is an important issue becomes clear if, for instance, for the good rainfall FAO Land/Water class of the model, the nitrogen loss over the 30 years centered around the year 1983 is expressed as a percentage of the total stock. In that case, assuming an average loss rate at the 1983 level[87] and a topsoil thickness of 20 cm with a bulk density of 1.25 g cm^{-3}, as much as 26% of the nitrogen stock would have been lost between 1968 and 1998. This seems in direct opposition to the yield increases over the last 30 years that were noted earlier.

The model is fairly optimistic about the soil fertility of most of the LUS's in the country, especially of the low rainfall zone which is attributed the highest soil fertility class. Based on our own samples, as well as a random selection of the literature (Boulet and Leprun 1969; de Graaff 1996; Krogh 1997b; Bationo *et al.* 1998), much lower values would be expected. Taking nitrogen and the good rainfall FAO Land/Water class again as

[87] This assumption seems reasonable within the logic of the model as the year 2000 scenariohas the loss rate increase 6 kg ha^{-1} (Stoorvogel and Smaling 1990: 39), it may be assumed that from 22 kg ha^{-1} in 1983 it will be reduced some 6 kg ha^{-1} going back in time to 1968.

an example, a topsoil nitrogen content of 0.05% would be expected rather than the 0.1% assumed by the model. Making this change in the reconstruction of the model results (because of reduced erosion losses) in a much lower N loss per year, namely 13 kg ha^{-1} instead of 22 kg ha^{-1}, but because the total stock is smaller, the earlier mentioned 30 year period would show a 32% loss of nitrogen stock, which is even harder to accept giving the observed yield trends.

A final point is therefore the issue of validation. Stoorvogel and Smaling (1990), in their evaluation of the results of the model, only provide a cross-check, as they call it, with long-term fertilizer experiments. As was already noted in section 5.2.2 and will be supported with further evidence later in this chapter, as well as the next chapter, such experiments cannot be compared with the on-farm, real landscape situation. A cross-check with experimental results can thus hardly be called a proper validation.

Taking all the raised issues together, there is good reason to treat the output of nutrient budget models with care (see also Krogh 1997a; Scoones and Toulmin 1998; Scoones and Toulmin 1999). It was shown that Stoorvogel and Smaling (1990), as probably most other scientists involved in the development of such models, are well aware of the simplifications and limitations of their product. But, what started as an interesting mathematical exercise often leads to far reaching conclusions in the hands of others (see Scoones and Toulmin (1999) on the influence of nutrient budgets studies on the policy debate).[88] In the foregoing sections, which may be regarded as an implicit attempt at validation, it was demonstrated that there is little evidence that nutrient depletion is as serious and widespread in Burkina Faso as the discussed model suggests.

The fact that according to the presented analyses soil productivity has so far been maintained in Burkina Faso under a wide range of population and livestock densities (both in terms of time and space) suggests that farmers have been able to adapt their management practices in response to population growth. Mineral fertilizers and mechanization are still not accessible for the majority of the Burkinabè households. Pieri (1989) for instance notes that in 1980 only 2% of the area under cereals received a form of fertilization and on only 0.25% of that same area "improved" seeds were used. Since then, total fertilizer use has increased, but is still largely restricted to cotton and other cash crops. In the research villages no fertilizer use was encountered for example. Alternative explanations that go beyond the increased, but still limited use of animal traction, will thus have to be sought for the steady increase of crop yields in conjunction with an apparent maintenance of soil fertility. With national level data it is difficult to address those issue for two reasons: (1) there is no nationwide soil fertility data available to examine the long-term effects of cultivation and (2) because the processes involved in crop production and fertility maintenance do not operate at the national level, but rather at the village and field level, it is difficult to explain any of the observed patterns. The subsequent sections will therefore step down to the regional, village, and field levels and examine actual soil chemical fertility data.

[88] A further problem is that with the general availability of computers and spreadsheet software everyone can adapt nutrient budget models to their own purposes without being aware of many of the pitfalls related to the parameters and other inputs used in the models.

5.5 Soil degradation in eastern Burkina Faso

The previous section has dealt with indirect indicators of soil degradation: changing yields and spatial variations in agricultural productivity. This section will also start out with such indicators, in order to determine whether the nationwide trends discussed in the previous sections also apply to the eastern region, the research area of this study. For this purpose population, yield, and production trends are analyzed in section 5.5.1. The second section (5.5.2), however, focuses on actual soil fertility data and tries to establish whether soil fertility has declined over the last 30 years. This question will be answered through a multi-temporal comparison of soil samples from the late 1960s, collected as part of a French soil survey, with those collected in the research villages in 1996.

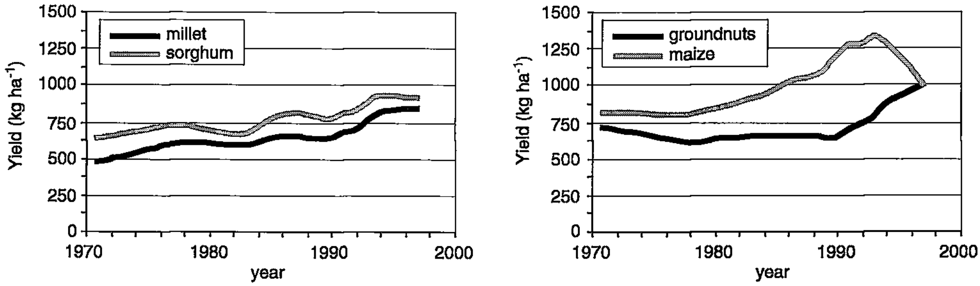
5.5.1 Population, yield, and production trends in eastern Burkina Faso

As was shown in chapter 4, Burkina Faso's eastern region has experienced more than a fourfold population increase in a little less than 40 years. As a result, the population density rose from some 4 inh. km^{-2} to over 18 inh. km^{-2} in 1996 for the region as a whole. In the past, as well as today, there are however important variations in population density ranging from a few inhabitants per square kilometer in the southeast to over 100 inh. km^{-2} in the northeast (chapter 4). Consequently, the area under crops also saw a strong growth. CRPA de l'Est (1992) estimates that between 1956 and 1988 the cultivated area (excluding fallow) doubled in Gnagna and Gourma provinces. Also the livestock population more than doubled in the last 25 years (chapter 4).

Given the rapid increase of pressure on natural resources and a lack of capital-led agricultural intensification, such as through mechanization and mineral fertilizer use, a negative effect on soil fertility might be expected according to both neo-Malthusian thinking as well as studies that argue the need for capital-led intensification (chapter 2). To see if this is the case, this section will analyze yield and production trends over the last 30 years, while the next section will consider changes in soil fertility.

Figure 5.9 shows yield trends for the major crops in the eastern region. Figure 5.9a reveals that millet and sorghum yields have experienced a steady growth with approximately a factor 1.5 in just over 25 years. Figure 5.9b shows that groundnut yields have been more or less steady until 1990 after which they increased with a factor 1.5, while maize has experienced a contrasting trend of steady growth between 1980 and 1990 followed by a rapid decline, which has resulted in an overall growth of little less than a factor 1.5. These trends are comparable to those found at the national level (section 5.4.2), though the yield growth of sorghum an millet is a little less pronounced than was observed at the national level, whereas the decline in maize yields appears to be more pronounced. It is possible that the decline in maize yields can be explained by an overestimation of those yields in the late 1980s and early 1990s, as it is difficult to find another reason for such a strong decline. In sum, the data suggests yield growth rather than decline, also for the eastern region.

Figure 5.10 shows the area and production per capita for millet and sorghum combined (i.e., the major staples). As can be seen from figure 5.10a, the harvested area per

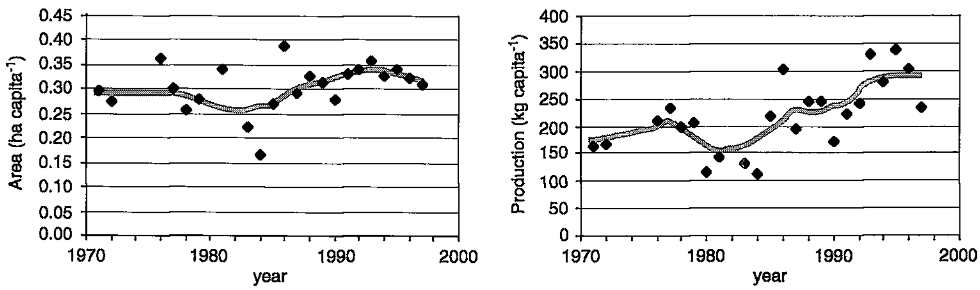


a. millet and sorghum yield trends *b. groundnut and maize yield trends*

Figure 5.9. Yield trends in Burkina Faso's eastern region (1971-1997)

Source: Table B.5 in appendix B.

Note: Trends are displayed using lowess (LOcally WEighted regression Scatterplot Smoothing) smoothing (Velleman 1997) with a span of 20%.



a. millet and sorghum area per capita *b. millet and sorghum production per capita*

Figure 5.10. Millet and sorghum area and production per capita in Burkina Faso's eastern region (1971-1997)

Source: Table B.5 in appendix B.

Note: Trends are displayed using lowess smoothing with a span of 20%.

capita, follows a pattern similar to that observed at the national level (section 5.4.2), with a decline towards 1984, followed by a steep rise after the 1984 drought and a renewed decline since the early 1990s. This suggests that also in the eastern region the population responded to the 1984 drought by at first cultivating more land and then, as yields were re-established at pre-drought levels, returning again to some 0.3 ha of millet and sorghum per capita. There is thus no sign of a process of more permanent extensification (i.e., using more land per capita). Production increase per capita must thus be attained through rising yields, rather than by cultivating more land.

Figure 5.10b shows that, due to the increasing yields (shown in figure 5.9a), the combined sorghum and millet production per capita has considerably risen since the early 1980s. The present level is considerably above the annual average cereal requirement per capita of 190 kg (MARA 1997b), without even taking into account maize and rice production. In other words, there is at present no indication that production will not be able to keep pace with population growth, especially since population growth has begun to slow down since the mid 1980s (table B.1 in appendix B).[89] As the amount of cultivated land per

[89] Over the period 1971 to 1997, production grew faster (6% per year) than the population (4% per year).

capita remained more or less stable, this suggests that there is no evidence of a production decline caused by soil degradation. To the contrary, there are clear signs of a low external input form of intensification, because mechanization and mineral fertilizer use in this part of the country is considerably below the national average (MARA 1996a), while as we have seen in chapter 4, also the use of animal traction is limited.

To conclude, in agreement with the findings at the national level, crop yield and production trends provide no evidence of widespread soil degradation in the eastern region.

5.5.2 Long-term changes in soil fertility

We will now turn to a multi-temporal analysis of actual soil fertility to examine whether, despite the fact that productivity indicators suggest an absence of soil degradation, there is any evidence of soil nutrient depletion. For this analysis, soil samples collected in the late 1960s by a French soil survey (Boulet and Leprun 1969) will be compared with those collected in 1996 in the research villages. Such a comparison is, of course, not without problems. There may be differences in the way soil has been sampled and in the procedures used for the various analyses. In addition, we will be comparing samples collected all over the region (the French survey) with samples collected in two villages, one in Gnagna and one in Gourma province (our samples).

As far as the differences in analysis are concerned, Boulet and Leprun (1969) do not provide any information in their report, making it impossible to take this aspect into account (see section 3.5.3 for the procedures used in this study). However, by focusing the comparison on total nutrients rather than on available nutrients (except for potassium for which totals are seldom determined), the effect of possible differences in chemical analysis methods is reduced. Concerning the difference in sampling strategy, samples spread over the whole region or samples collected in two villages, it is difficult to say how much this will influence results. It is important to note, however, that Boulet and Leprun frequently present tables giving average values of fertility factors per soil type, without making any distinction between soils in the northern or southern part of eastern Burkina Faso. In only one case, for the "sols peu évolues d'érosion a faciès ferrugineux sur matériau gravillonnaire", a distinction is made between samples collected north and south of the 14th degree latitude (Boulet and Leprun 1969: 54). This suggests that, generally speaking, they consider the variation in soil characteristics small enough to aggregate observations from different parts of the area. As the research villages represent two different parts of the region in terms of their latitude (Samboanli: 12°30' N; Pentouangou 11°55' N) and are centered more or less within the region covered by the samples of the French survey that will be considered here (11° to 14° North) there should be no a priori objection against the comparison, nevertheless the difference in approach will require care in drawing conclusions.

The comparison will be restricted to the topsoil as the fertility of that part of the soil is most relevant for agriculture and also most prone to changes as a result of soil degradation. Four chemical properties will be compared: total carbon content (%C), total nitrogen content (%N), total phosphorus content (%$P_2 0_5$) and exchangeable potassium (K in meq. $100g^{-1}$). To increase the reliability of the comparison, two sets of comparisons will be made

Table 5.10 Comparison by soil type of chemical soil fertility between the 1969 French soil survey and the 1996 samples

	Sols peu évolués		Sols ferrigineux lessivés		Sols brun euthrophes	
Fertility indicator	1969	1996	1969	1996	1969	1996
	(N = 17)	(N = 4)	(N = 14)	(N = 5)	(N = 33)	(N = 4)
%C	0.88	0.83	0.64	**0.98**[a]	0.73	**1.13**[a]
%N	0.059	*0.032*[a]	0.044	0.041	0.057	0.045
$\%P_2O_5$	0.025	0.025	0.032	0.036	0.032	0.038
K (meq. $100g^{-1}$)	0.18	0.12	0.13	**0.24**[a]	0.19	0.21

Sources: Boulet and Leprun (1969) and fieldwork.

[a]Figures in bold or italic indicate respectively a considerably higher or lower mean value for 1996. Because the data from the French survey are aggregates it is impossible to test the significance of the observed differences.

using different data sets for both years. The first comparison will be based on soil type and the second one on land use.

For the by soil type comparison the summary tables giving the topsoil averages of the chemical properties per soil type of the French survey are compared with the averages of the topsoil of the 13 soil profiles that were described and sampled in the research villages. In both cases the samples were taken during the dry season. The three main soil types in the region, “sols peu évolués”, “sols ferrigineux lessivés”, and “sols brun euthrophes”, were used for the comparison. As table 5.10 shows, few differences can be observed between the 1969 data and the 1996 data. Of the four figures showing a considerable difference between both years three show higher values in 1996 and only one, total nitrogen content of the “sols peu évolués”, shows a considerably lower value in 1996. As the difference in nitrogen contents does not seem to be linked to a decline in carbon content this may be an indication of an increased C:N ratio in 1996, suggesting the presence in the soil of less decomposed organic matter. This might be a result of the declining rainfall and the incorporation into the soil of more difficult to decompose organic materials. On the whole, however, it may at this stage be concluded that the comparison does not point to a decrease in chemical soil fertility over the last 27 years.

For the comparison based on land use, data was used from the individual soil profile descriptions given in the report of the French survey. For each of these profiles the chemical properties of the first horizon were considered.[90] For the earlier mentioned reason, profiles located north of 14°N were not considered. In Boulet and Leprun (1969) a total of 31 profiles with land use information were found between 11° and 14° North, of which 24 were uncultivated and 7 were cultivated (all bush fields). Their average latitude is 12°06’ N, which coincides reasonably well with the location of the research villages (11°55’ N and 12°30’ N). These observations were compared with our own topsoil samples (0-20 cm) that were collected, at the end of the rainy season, on a large number of bush fields (61 samples) and uncultivated sites (36 samples) in the research villages. To have a fair comparison no village and compound field samples were included in the analysis.

[90] The average depth of the first horizon of the French profiles is 14 cm. In some cases no depth was specified but just A1 horizon.

Table 5.11 Comparison by land use of chemical soil fertility between the 1969 French soil survey and the 1996 samples

Fertility indicator	Uncultivated		Cultivated	
	1969 (N = 24)	1996 (N = 36)	1969 (N = 7)	1996 (N = 61)
%C	0.78	0.94	0.8	0.86
%N	0.056	*0.046*[a]	0.054	0.055
$\%P_2O_5$	0.037	0.025	0.037	0.036
K (meq. $100g^{-1}$)	0.15	**0.27**[a]	0.24	0.32

Sources: Boulet and Leprun (1969) and fieldwork.

[a]Figures in italics or bold indicate respectively a significantly lower or higher mean value for 1996, at the $\alpha = .05$ level with a two-sample t-test of the means.

Table 5.11 presents the results of the comparison by land use. It is immediately apparent that there are few differences. Only total nitrogen of the uncultivated samples is significantly lower in 1996 than in 1969 (based on a two-sample t-test), pointing again at changes in the C:N ratio of organic matter. All other figures are comparable, with the exception of potassium on uncultivated soils which is significantly higher for the 1996 data. Just as the "by soil type" comparison, the "by land use" comparison does not provide evidence of a decrease in soil fertility over the last 27 years. As a whole the studied chemical properties are remarkably similar for both years. In addition, the "by land use" comparison, shows that there are little, if any, differences between the properties of uncultivated and cultivated soils suggesting that the type of cultivation practiced on bush fields does not lead to a significant reduction in soil fertility compared to uncultivated sites (that in the case of the 1996 samples had not been cultivated for 20 years or more).

It may be concluded that a comparison of soil samples collected in the eastern region with a 27 year interval does not provide any evidence of soil degradation. Even if the differences in sampling procedure, sampling locations, and (possibly) chemical analysis, are considered, the observed chemical soil fertility indicators are remarkably similar for 1969 and 1996. This implies that despite a strong population growth and a significant expansion of the cultivated area there is no evidence of decreasing chemical soil fertility as a result of agricultural land use.

5.6 Soil degradation in the research villages

5.6.1 The influence of population pressure on soil fertility

In neither the national nor the regional level analysis, was any evidence found of population pressure leading to a decline in productivity of the land that in turn could be an indication of soil degradation. At the regional level, it was furthermore established that despite strong population growth there was no indication that soil fertility has declined over the last 27 years. Given the prominence of the issue of population pressure in the land degradation debate (chapter 2), this section, for one last time, tries to establish whether, if not at the national or regional level, such a relationship perhaps can be established by looking at the

Table 5.12 Population pressure in Pentouangou and Samboanli in 1996

Village	Latitude	Proportion of village territory under cultivation[a]	Population density	Livestock density in province (1994)
Pentouangou	11°56'N	5%	13 inh. km^{-2}	9 TLU km^{-2}
Samboanli	12°30'N	20%	50 inh. km^{-2}	26 TLU km^{-2}

Sources: Location was determined with a GPS. Livestock figures are derived from MARA (1995a). For other data see section 4.8.1.

[a]This is the area cropped in a single year and excludes fallows.

more detailed data available at the village level. For this purpose the chemical fertility status of the soils in the two research villages was investigated. These villages provide good material for comparison as there is a considerable difference in the pressure on natural resources between the two villages. Pentouangou, the southern research village is located in an area that has historically had a low population density, one of the lowest in the country. Samboanli, the northern research village, is located in an area that has always been relatively densely populated. These conditions still prevail today as can been seen from table 5.12.

In chapter 4, we have seen that there are no fundamental differences between the farming systems in both villages. Therefore, if pressure on natural resources matters, it would be expected that the factor four difference between the villages, in terms of the proportion of the area under cultivation and the population density, would reflect on the chemical fertility status of the soils. Following a Neo-Malthusian scenario, chemical soil fertility can be expected to have declined in Samboanli. Following a Boserupian style scenario there are two possibilities: (1) population increase has led to a decline in soil fertility in Samboanli as a result of over exploitation of resources because the point has not yet been reached where investments in land and external inputs become remunerative; or (2) soil fertility (on cultivated soils) is actually higher in Samboanli than in Pentouangou, because the higher population density of Samboanli has stimulated better land husbandry.

Table 5.13 gives the fertility indicators that will be considered in our analysis. Details on how these were measured and concerning the sampling setup can be found in section 3.5.3. A total of 135 topsoil samples were collected of which 11 were excluded from the analysis because these were on rare soils or soils with very specific properties such as those formed on old termite mounds. As was explained in section 3.5.3, soil samples were taken on both cultivated plots and uncultivated areas. In principle two bulk samples were collected per plot. One on the site indicated by the informant (usually the farmer) as the best part of the plot or uncultivated area and one on the site indicated as the worst part of the plot or uncultivated area (plate IV).[91]

Table 5.14 presents the explanatory or independent variables that were used in the analysis of the soil sample data. The analyses in this section will all be based on the use of General Linear Models (GLM). Because two samples were collected for each plot or uncultivated area, a so-called nested design was used in which the variable 'plot' was

[91] This farmer judgement is primarily based on differences in soil organic matter, the prime source of soil fertility according to Gourmantché farmers (chapter 6).

Table 5.13 Dependent variables: Fertility indicators

Variable	Description	unit	transformation
%OM	organic matter content of the topsoil	%	log
%N	Nitrogen content of the topsoil	%	log
P-total	Total phosphorus content of the topsoil	mg kg^{-1}	log
K-avail	Available potassium of the topsoil determined with the K-HCl method	mg kg^{-1}	log

Note: All dependent variables are continuous. For transformations, see note (a) with table 5.6.

Table 5.14 Explanatory variables

Variable	Description	unit	transformation
Plot	Plot or uncultivated area where sampling took place		
Site	Site on plot or uncultivated area specified by the informant as: *good* or *bad*.		
Soil class	Soil class according to the local soil classification (see chapter 6): *baagu*, *boali*, *tanbiboanli*, *tanbimoanli*, *tanbipieni*, *tancagu*, and *tinboanli*.		
Soil texture	Sand:clay-ratio	%/%	log
Village	Research village: *Pentouangou* or *Samboanli*.		
Land use	Land use classified as (see chapter 4): *uncultivated*, *bush field*, *village field*, and *compound field*.		

Note: All explanatory variables are discrete except for soil texture. Soil texture was expressed as the logarithm of the sand:clay-ratio. Compositional data, such as soil texture, are often expressed as the logarithm of one component divided by another component (Aitchison 1986).

nested in research village and/or land use (depending on whether these factors are included in the analysis), because each plot is found in only one village and can have only a single land use type. In this design the variable 'site' functioned as a repeat in that for each plot two measurements were taken one at the good and one at the bad site. Plot was not nested in soil class as the good and bad sites often had different soil types. The variable 'soil texture', the only continuous explanatory variable, functioned as a covariate in the analysis that could vary independently of plot. The ANOVA tables of the analyses can be found in the appendix C (tables C.3 and C.4), here we will limit ourselves to summary figures and tables.

As the sampling design was not balanced in terms of having exactly the same number of samples for each village, on each land use type, and on each local soil type, a comparison of the villages is not straightforward. The GLM, however, corrects for these factors before evaluating the differences between the villages.

As can be seen in table 5.15, neither the factor village nor its interaction with the factor site shows any significance (p-value < .05) for any of the fertility indicators.[92] This implies that there are no significant fertility differences between the villages in terms of the

[92] The interaction between village and site makes it possible to evaluate the combined effect of these two factors and determine whether soil fertility, as measured for the factor village, shows a different pattern for good and bad sites.

Table 5.15 Significance of the factors village and interaction of site and village for the fertility indicators (p-values)

Factor	%OM	%N	P-total	K-avail
Village	.46	.66	.64	.55
Site * Village	.29	.16	.52	.18

Source: Table C.3 in appendix C.
$^{*}p < .05$. $^{**}p < .01$.

chemical soil fertility of similar soils and land use types.[93] This suggests that there is no relation between the fertility of the soils and the pressure on natural resources. This result seems to counter not only both the Neo-Malthusian and the Boserupian scenario, it is counter intuitive. At first sight, it is difficult to understand why there is no difference between the villages. In section 5.3 it was noted that the proportion of the village territory used for arable farming (cultivated land and short-term fallows) was, with 65% in 1994, several times larger in Samboanli than in Pentouangou. On the basis of table C.2 in appendix C it can further be concluded that only one-fourth of the Samboanli village territory was not used for agriculture in either 1955 or 1994. There are no data available on the years between 1955 and 1994 or the period before 1955, still it is likely that all cultivable soils on the Samboanli village territory have been cultivated at sometime in the recent past. This is confirmed by informants, in that there are few "unclaimed lands" left. Assuming that cultivation leads to a decline in soil nutrients, the soils in Samboanli should have been negatively affected due to the fact that they have been cropped with much greater frequency than in Pentouangou. Whether this assumption holds will be the topic of the next section.

5.6.2 The relation between land use and chemical soil fertility

Continuing with the same data-set, fertility indicators, and explanatory variables, used in the previous section, this section, instead, deals with the relation between land use and chemical soil fertility. It addresses the issue of how cultivation affects soil chemical fertility, whether cultivated soils show a lower fertility than (long-time) uncultivated soils, and how different intensities of land management affect soil fertility.

To examine the relation between land use and chemical soil fertility, four land use types were defined (in order of management intensity): uncultivated land, bush fields, village fields, and compound fields. This is a commonly recognized division in West African village agriculture (by farmers and researchers alike, see for example Vierich and Stoop 1990; Prudencio 1993). Summarizing the information that was presented in sections 3.5.3 and 4.6.2 the following distinctions in terms of use and fertility management can be made between the four land use types. Uncultivated land is left fallow and used only for firewood and wild fruit collection, as well as for extensive grazing. Most of the

[93] This does not imply that one of the villages cannot be endowed with better soils than the other in terms of having larger areas covered with good soils than the other village, it only implies that there are no significant fertility differences on the same soils under the same land use.

Table 5.16 Significance of the factors land use and interaction of site and land use for the fertility indicator (p-values)

Variable	%OM	%N	P-total	K-avail
Land use	.595	.084	.018*	.002**
Site * Land use	.001**	.008**	.001**	.347

Source: Table C.4a in appendix C.
$^{*}p < .05$. $^{**}p < .01$.

uncultivated land (and all our samples on this type of land) is at some distance from the village. Uncultivated land, as we sampled it, has sometimes never been cultivated, but in most cases has been cultivated 20 or more years ago in the form of bush fields. Bush fields are at some distance from the village and are generally cultivated in an extensive manner because the fields are large and only cultivated for a limited number of years (usually some 5 to 10 years in the research villages). Village fields are found within the village and are generally cultivated for many years in a row, followed by a limited fallow period. These relatively small fields are used more intensely than bush fields, but receive relatively few external inputs. Compound fields are very small fields that are found inside the village on the land immediately surrounding the compounds. They are cultivated intensively for many years without fallow, but soil fertility is maintained through external inputs in the form of organic matter. As can be seen in table 5.16, this division in land use types makes sense in that both the factors land use and the interaction of site and land use are significant (p-value $< .05$) to very significant (p-value $< .01$) for most of the fertility indicators. Through the GLM corrections were made for soil class and texture. Village had no significant effect and was therefore removed from the analysis.

Considering the type of management applied to these different land use types it may be hypothesized that bush fields have a more or less similar fertility to uncultivated land. Village fields may be hypothesized to show a lower fertility than uncultivated land because of the long-term exploitation without sufficient compensation in the form of external inputs. Compound fields, which are exploited in an intensive manner, both in terms of the duration of cultivation and in terms of the application of external inputs, may be hypothesized to show the highest fertility.

Organic matter

In order to determine the relative fertility of the different land use types, the expected cell means were calculated and the Scheffé Post Hoc test (Velleman 1997) was applied to determine the significance of the differences between the cell means (for more details see table C.4b in appendix C). Figure 5.11 shows the expected cell means of organic matter for the four land use types.[94] From the figure it can be seen that bush fields and compound fields show a significant difference between good and bad sites whereas there is hardly any difference between good and bad sites for uncultivated and village land. It can further be

[94] To make the results easier to interpret the log-transformation used during the analysis (see table 5.13) was inverted again (10^x) to return the fertility indicators to their original units.

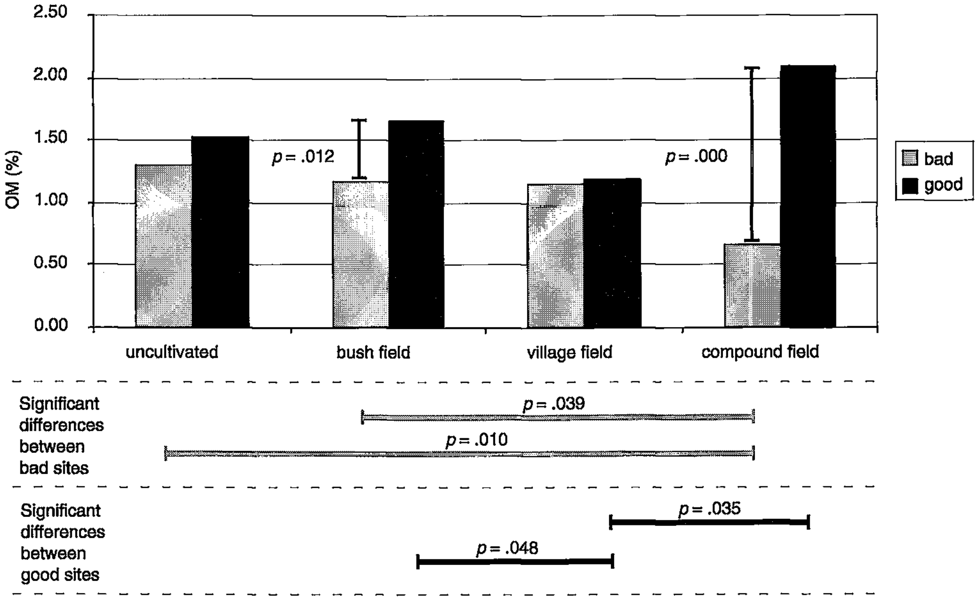


Figure 5.11. Expected cell means for organic matter and significance of differences according to the Scheffé Post Hoc test
Source: Table C.4b in appendix C.

seen that the bad sites on compound fields show a significantly lower organic matter content than those on uncultivated areas and bush fields. Finally, the figure shows that as far as the good sites are concerned village fields are significantly lower in organic matter content than either compound or bush fields. What does this tell us about the soil fertility effects of the different types of land use?

1. Bush fields do not show a significantly lower organic matter level than uncultivated land. This suggests that the effect of 'bush field style' cultivation is limited;

2. There is a large difference between good and bad for bush fields. This difference is larger for bush fields than for uncultivated land. A possible explanation is that cultivation sharpens the contrast between good and bad portions of a plot. However, the larger difference may also be an artifact of the fact that informants were better in locating the good and bad sites on their fields than on long-term uncultivated land;

3. The effects of cultivation are most visible on the village and compound fields. Village fields show a low overall organic matter level as a result of long-term cultivation without sufficient inputs, while compound fields show a large range of organic matter content because some areas receive enough organic matter input to more than compensate for the effects of long-term cultivation, while other parts are cultivated just as long, but receive very few inputs.

We will now consider whether this pattern, observed on the basis of organic matter, is also found for the other fertility indicators.

Nitrogen

Figure 5.12, which shows the nitrogen expected cell means and the significance of their differences, generally confirms the pattern found for organic matter. There are two main differences however. First, the bad sites appear to show much less variation. Secondly, the nitrogen content of the good sites of both the bush fields and compound fields is significantly higher than that of the uncultivated areas. In this the figures for nitrogen strengthen the visible but not significant pattern that can be observed in figure 5.11. Both of these observations are most likely the result of tillage and weeding that causes a better incorporation of organic matter into the soil on fields compared to uncultivated areas, which leads to lower C:N-ratios for the cultivated soils.

Total phosphorus

Figure 5.13, which shows the total phosphorus expected cell means and the significance of their differences, shows a quite different picture. There is a similarity in only two aspects. For compound fields there is still a significant difference between good and bad sites. Secondly, the uncultivated area continues to be lagging behind in terms of the fertility level of especially the good sites. For phosphorus this difference is not only very significant for bush fields and compound fields, as was found for nitrogen, but even village fields show a very significantly higher phosphorus level compared to uncultivated areas. In fact, village fields for the first time show a (significantly) higher fertility than bush fields. These

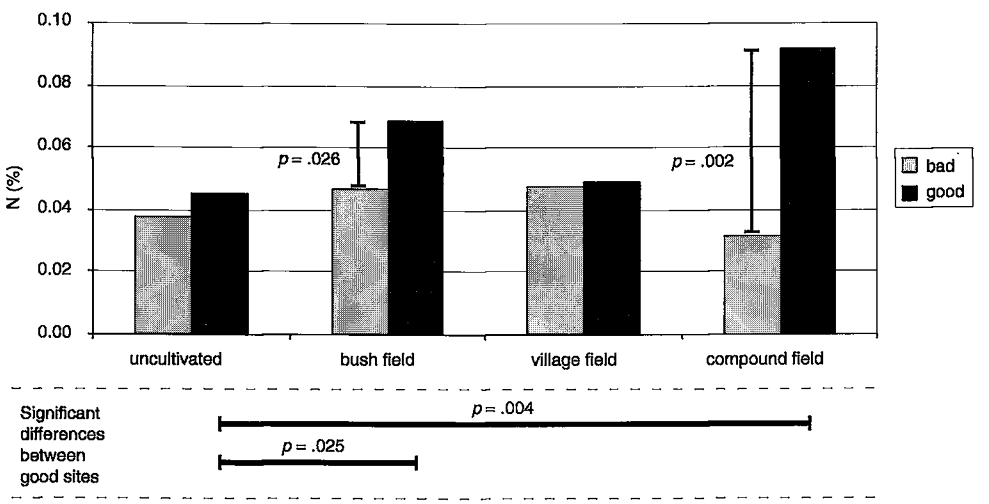


Figure 5.12. Expected cell means for nitrogen and significance of differences according to the Scheffé Post Hoc test

Source: Table C.4b in appendix C.

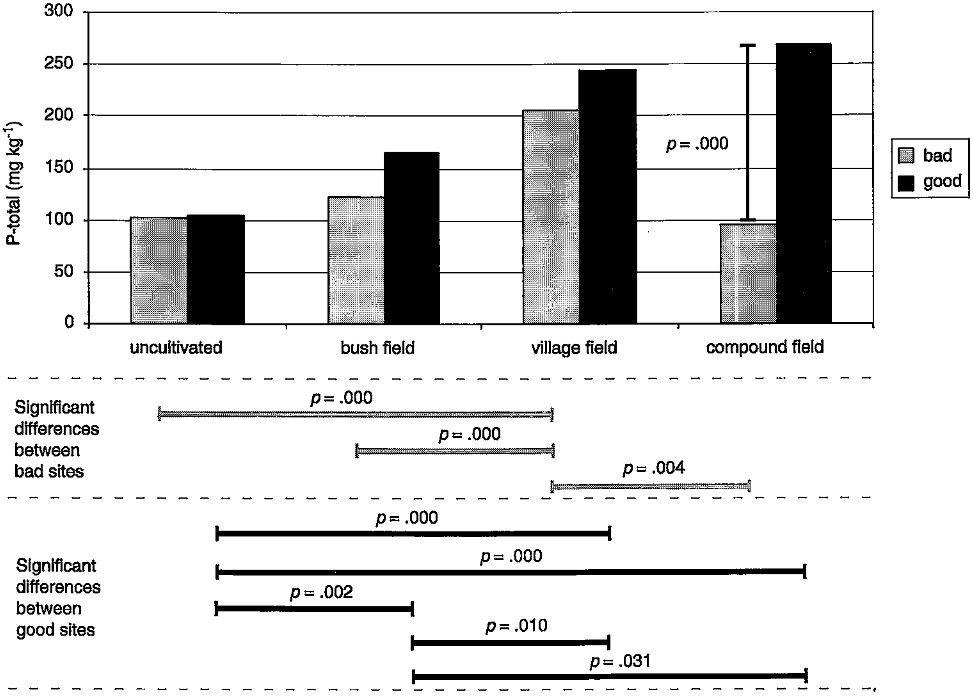


Figure 5.13. Expected cell means for total phosphorus and significance of differences according to the Scheffé Post Hoc test

Source: Table C.4b in appendix C.

observations suggest that cultivation actually leads to increased levels of total phosphorus. This can probably be attributed to a combination of factors such as the earlier mentioned better incorporation of organic matter, but also to manure derived from animal grazing on stubbles and stalks, while animals roaming around in the village during the dry season may be responsible for the even higher amounts of phosphorus measured on the village and compound fields, the latter of which in addition receive manure collected in the compound. The relatively low phosphorus level of the bad sites of the compound fields can be explained by the fact that, just as the rest of the compound field, these sites are cultivated continuously (sometimes over 70 years), but that, unlike the good sites, they receive no manure and compound refuse from the farmer. Droppings from livestock and other organic matter are, according to informants, washed away from these sites because of the micro-topology and soil crusting.[95]

Available potassium

The last figure in our analysis, figure 5.14, shows the available potassium expected cell means and the significance of their differences. This figure again follows the general

[95] Another factor may also be that if there is any location where farmers know exactly what the very poorest sites are, it is on the long-term cultivated compound fields.

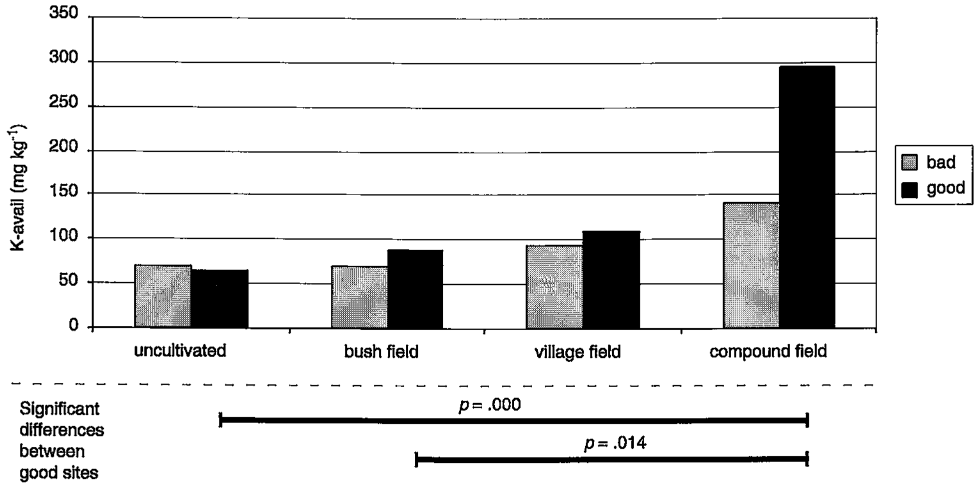


Figure 5.14. Expected cell means for available potassium and significance of differences according to the Scheffé Post Hoc test
Source: Table C.4b in appendix C.

pattern, but shows few significant differences. The main points are that uncultivated areas and bush fields do not show a significant difference, whereas the compound fields again show a significantly higher fertility than the uncultivated areas an bush fields. Manure, but especially household refuse and cooking ashes are likely to be the explanations for the higher potassium availability on the compound fields.[96]

Discussion

Returning to the earlier mentioned hypotheses, it may indeed be concluded that of all field types, the bush fields most resemble the uncultivated areas in terms of their fertility. Surprisingly, the two factors on which they are significantly different, nitrogen and phosphorus, actually show a difference in favor of the bush fields. This may be attributed to the already mentioned increased input of cattle dung on the bush fields as a result of stubble and stalk grazing. Another explanation might be an increased nutrient turn-over rate during the first years of cultivation. When an area is cleared for cultivation for the first time, bushes and most of the trees are cut-down. Tree trunks are usually burned in situ, but branches may either be burned in situ or spread over the soil to decompose and stimulate termite activity (on the role of termite activity in breaking down litter and improving soil physical and chemical properties for plant growth see Mando 1998; Mando and Brussaard 1999; Mando *et al.* 1999). As a consequence, a lot of organic matter is released to the soil during the first years of cultivation that would otherwise have remained in the standing

[96] The relatively small differences between the expected cell means for the good and bad sites are related to the fact that there is a relatively small correlation between available potassium levels and what farmers indicated as respectively good and bad sites. This implies that the actual range of available potassium may be much greater than figure 5.12 suggests.

natural vegetation. A peak may be expected during the second or third year when the process of decomposition and incorporation of organic matter in the soil has reached its maximum. This would imply that the higher fertility of bush fields compared to uncultivated land last only a few years after which the fertility will decline again as a result of crop cultivation. By that the time, the field has to be either improved through soil and water conservation practices or be abandoned. Such a sudden but temporary release of organic matter to a newly cleared field is in agreement with the fact that several informants reported that a new field generally performs relatively poorly during the first two years, attains maximum performance during the next few years, and generally begins to decrease in productivity again after the fifth or sixth year.[98] Ahandi Nassouri explains:[99]

> If you cultivate a new field for the first year you will harvest less than during the second year, and during the second year you will gain less than during the third year. This is because during the first year the organic matter is not mixed with the soil. In the second year the organic matter is mixed a little bit with the soil and in the third year it is well mixed. In the fourth year, going towards the fifth and sixth year the organic matter starts to decrease because the plants ... drink organic matter.

The transformation of the physical soil structure, however also plays a role, as Adama Yenloli Nadinga suggests:[100]

> In the first year of cultivation a new field does not perform very well. Some parts will yield well, others will yield poorly. If I would not have used a plow this effect would have been much stronger. This has nothing to do with soil organic matter, but with the fact that animals have trodden on the soil. If you till the soil it will become very compact after it rains and the water will not penetrate well. In the second year it will be much better, better even than in this year's good parts. The places where I have burned branches of cut-down trees will perform well this year, but because of the burning the soils dies and looses its strength [plate V]. Now there is soil organic matter because of the burning. Next year there will be no organic matter because there will not be any weeds left. But I will put stalks in those places and not burn them, so that the soil will be good. Continued burning would lead the soil becoming denuded.

The limited effect on soil chemical fertility of "bush field" style cultivation is confirmed by Pieri (1989), who notes that the few available studies, observed little difference in soil chemical properties after a short-duration of cultivation (4 to 9 years) on

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[98] Siband (1974) who studied the effects of a long-term "traditional" millet-groundnut rotation (with a few years of fallow once in a while) on soils in Senegal's Casamance also observed that yields were lower during the first years after clearing, followed by an increase and later a decline again. In this case the peak was recorded around the 12th year of cultivation, but the original forest vegetation had been more lush than the natural vegetation in our research villages. Siband concluded that this phenomenon is probably related to the way the land is cleared (slash and burn) and with the abrupt ecological alterations of the soil flora and fauna that needed to adjust itself to cultivation.

[99] Interview held in Pentouangou on 15 October 1996.

[100] Interview held in Samboanli on 25 September 1996.

land that had been under long-term fallow (rather than forest). He remarks, however, that nevertheless after 3 to 6 years of cultivation yields are reduced and fields are abandoned, related to "une détérioration des états physiques de surface et une aggravation des états de salissement des parcelles" (Pieri 1989: 116). This is in agreement with the situation in the research villages were farmers generally abandon a bush field because of yield decline and weed infestation, but before serious soil degradation sets in.

It was also hypothesized that village fields would show a relatively low fertility due to long periods of cultivation and few organic inputs. In terms of organic matter this was indeed the case, while also the nitrogen levels appeared to be relatively low. In terms of phosphorus this was, however, definitely not the case. The village fields showed an unexpectedly high total phosphorus level. As expected, compound fields in each case showed the highest fertility levels. With one "but", the poor sites of the compound fields showed some of the lowest levels of nutrients in relation to the poor sites of the other land use types.

On the whole, it appears that cultivated sites show a higher fertility than uncultivated sites, especially in terms of the nitrogen and phosphorus levels. This does not imply that cultivation is the major solution to prevent nutrient depletion. Rather, it suggests that with appropriate management practices cultivation does not have to lead to chemical soil fertility decline. In other words, farmers in the research villages seem altogether to have found a good balance between duration of cultivation and intensity of management. Those fields for which there may be some reason for concern, namely the village fields, cover only relatively small areas (section 4.6.2). Prudencio (1993), who carried out a similar kind of analysis for two Mossi farming systems on Burkina Faso's densely populated Central Plateau, in the Sudanian and Sudano-Sahelian zones, respectively, also found cultivated soils to be at least as fertile as old fallows. According to his analysis, soil fertility of fields on upland soils is either higher than, or not significantly different from, that of old fallows (10 to 40 years), while for lowland soils, only organic matter appears to be lower on cultivated soils than on old fallows.

An important question, of course, is whether the studied farming system achieves the improved fertility of cultivated soils to the detriment of uncultivated bush land because of nutrient transfers through livestock. This seems unlikely for several reasons. Firstly, deliberate manure use is limited to small plots or minor portions of larger plots, while an important proportion of livestock goes on transhumance and thus does not contribute to nutrient transfers within the village territory. Secondly, for example Powell and Valentin (1998), claim that, in West Africa, even in situations of intense grazing pressure, livestock exports of N and P from rangelands are marginal. Finally, the analysis in section 5.5.2 indicated that there is no evidence of a decline in fertility of uncultivated land in the research area between 1969 and 1996.

This brings us to another important question. It is conceivable, as for instance Berkhout *et al.* (1997) suggest for Borgou province in northern Benin (an area bordering on Burkina Faso's eastern region and with similar population densities, de Haan 1997), that the relatively low fertility of uncultivated land, and the fact that it does not appear to be more fertile than cultivated land, is due to a general exhaustion of soils in the area. In that case, soil nutrient depletion has attained such a level that fallows cannot sufficiently regenerate and that fields may be more fertile than uncultivated land because they receive external inputs, while fallow land does not. Such a scenario is, however, unlikely to be able to explain the observed soil fertility patterns in the research villages for two reasons. Firstly, the just mentioned multi-temporal comparison showed that soil fertility has not declined since the late 1960s. It is extremely improbable that already at that time, when population density in the eastern region was only 6 inh. km^{-2} (estimated from table B.1 in appendix B), soils had already been completely exhausted. Secondly, it is just as implausible that in Pentouangou, with a present population density of only 13 inh. km^{-2}, 20 to 50 years of fallow would not be able to regenerate soil fertility. Based on these observations, it is much more likely that the relatively low fertility of soils in this part of West Africa is a natural state (related to geological, geomorphological, pedological, and climatological conditions), rather than the result of extensive nutrient mining. The evidence presented in Berkhout *et al.* (1997) might in that case be a proof of effective soil fertility management by farmers in northern Benin, rather than a sign of total exhaustion of the soils, as they now claim.

It should be realized that the present analysis focussed only on chemical soil fertility as indicated by organic matter and the three macro nutrients: nitrogen, phosphorus and potassium. While micro-nutrients may be an issue, there is no a priori reason to expect them to follow very different patterns from those just discussed, and what is more, the literature suggesting widespread nutrient depletion also focuses mainly, if not completely, on these macro-nutrients. A more serious concern may be the physical soil fertility. Lack of nutrient depletion does not automatically imply that there is no degradation of the soil physical structure and properties. Still, the fact that organic matter, which is strongly correlated with soil physical stability (Dutarte *et al.* 1993), does not seem to be negatively affected in the presently discussed cultivation system is an indication that, aside from the village fields, the soil physical fertility might not be too much negatively affected under current management conditions. In addition, Pallo (1982), who studied the soil physical and chemical differences between uncultivated soils and soils on bush fields that had been cultivated for up to 3 years on an east-west transect near Fada N'Gourma, concluded that the "traditional" style of cultivation did not lead to alterations of the soil morphological and physical properties. Another factor to consider is soil biological fertility and in particular the role of the soil microflora. In general, land degradation studies pay little attention to this aspect of soil fertility and also in the present study it was not investigated. Still, the observed increase in crop yields, as well as the apparent maintenance of soil organic matter in the research area and villages, does not provide a reason to expect soil biological fertility to have declined in a situation where chemical fertility was maintained without the use of mineral fertilizers.

These disclaimers aside, the analysis of soil samples presents strong evidence that management, rather than population pressure, is the determining factor influencing chemical soil fertility. This suggests that in contrast to Neo-Malthusian and Boserupian thinking land management practices may actually evolve independently from population pressure. This implies that, without requiring any population thresholds or revolutionary changes in terms of the use of external inputs and mechanization (chapter 2), farmers gradually adjust their management practices to maintain soil fertility. How these adjustments take place and the kind of land management practices the farmers use is the topic of the following chapters.

5.7 Conclusions: land degradation, the land – population debate, and sustainability

This chapter began with a discussion of the concept of land degradation, commonly defined as a decline in productivity of the land (Blaikie and Brookfield 1987; CCD 1997), and its dependence on the view of different stakeholders. It then argued that while perception is a fundamental issue, it is one of the two pillars on which the land degradation narrative rests. The other pillar is the scientific evidence that the productivity of the land is changing. It was further argued that it would be possible, by focussing first of all on this second pillar, to make an important contribution to developing a more articulated view on the processes affecting the land, without requiring to immediately deal with the issues of stakeholders' perception.

It was pointed out that land degradation cannot be measured directly but requires the use of proxies relating to the condition of the land (e.g., soil, water, vegetation) and to the productivity of the land. This implies that claims of widespread environmental destruction in West Africa, should be questioned in light of the inherent weaknesses of the proxies and data on which it is based. It was further argued, that the most effective way to question the land degradation narrative would be to do so based on triangulation of some of the same indicators and proxies on which it is based: such as crop yields, agricultural productivity, biodiversity, and soil fertility. The remainder of the chapter analyzed spatial and temporal trends of these indicators, for Burkina Faso, at three different scales: the national level, the regional level and the village level.

It was found that vegetation dynamics are far too complex to catch in a simple deforestation figure such as the number of hectares cleared per year, as is commonly done for Burkina Faso (MFP 1993; MEE 1996). It was concluded that it may be much more appropriate to describe the changes in vegetation cover and species composition in terms of dynamically changing landscapes (Leach and Mearns 1996), rather than in terms of land degradation, which suggests a uni-directional downward trend. This is a point that is also supported by several recent remote sensing studies that showed a remarkable resilience of the vegetation after periods of declining rainfall (Nicholson *et al.* 1998; Prince *et al.* 1998).

A temporal analysis at the national and regional level of crop yields and agricultural productivity also provided little evidence of a downward trend that might be attributed to land degradation on cultivated soils. On the contrary, yields and productivity appeared to be increasing, both nationally and in the research area, despite strong population growth and a decline in rainfall since the wet 1950s. A national level spatial analysis of agricultural productivity only further confirmed that population pressure did not significantly affect land or labor productivity. Modern technology use was found to play only a minor role, which suggests that farmers have found other ways to deal with rising populations while apparently maintaining the fertility of their soils. This is unlike what the land degradation literature (see for example Vierich and Stoop 1990; MFP 1993; Cleaver and Schreiber 1994; Kessler *et al.* 1995; Bationo *et al.* 1998; Breman 1998) would suggest, or what nutrient budget models, such as that of Stoorvogel and Smaling (1990) predict.

Also a multi-temporal comparison of soil samples collected in eastern Burkina Faso provided no evidence of changes in soil fertility between the 1969 and 1996 that could point at nutrient mining. This evidence was further supported by a spatial analysis of soil chemical fertility under different types of land use in the research villages. On the basis of this analysis, which found cultivated land to be often more fertile than long-time uncultivated land, it was concluded that through management farmers are able to maintain soil fertility irrespective of population pressure and environmental change. A conclusion also supported by several other studies on the relationship between farm management and soil fertility that were carried out in others parts of Burkina Faso (e.g., Prudencio 1993; Gray 1999).

All in all, there appears to be little supporting evidence of widespread land degradation in Burkina Faso, as it is generally claimed to exist (see for example Vierich and Stoop 1990; Ramaswamy and Sanders 1992; MFP 1993; PNGT 1993; Kessler *et al.* 1995; MEE 1996).[100] Given the strong population growth observed over the last 40 years and the relatively high rural population densities found in large parts of the country, this appears at present to exclude a Neo-Malthusian doomsday scenario which predicts a downward spiral of soil degradation and starvation as a result of uncurtailed population growth (chapter 2). In agreement with Boserupian thinking, the evidence put forward in this chapter suggests that some form of agricultural intensification is instead taking place that allows food production to grow along with population. However, there seems to be little evidence that this form of intensification is based on high use of external inputs and increased mechanization. Neither are there any indications that certain population thresholds need to be surpassed before farmers undertake intensification or improve the environmental sustainability of their land use practices. How this intensification takes place and in what form is the topic of the upcoming chapters

This chapter also pointed to some weaknesses in the kind of studies that underpin the current land degradation narrative, such as erosion studies, long-term experimental plot studies, and nutrient budgets studies. The methodology of these studies needs to be improved in several ways. Most notably, they need to deal better with the spatial and temporal dimensions of the problems they observe (Fresco and Kroonenberg 1992). In specific, more farm and village level measurements need to be made and, if this is not possible, the consequences of upscaling measurements from plot level to farm, village, watershed and regional level need to be better understood and the procedures involved need to be improved. More attention should also be given to the aspect of site-specificity of measurements, the lack of baseline data now all too often leads to the use of measurements that were made under very different circumstances in very different areas (Scoones and Toulmin 1998).

Furthermore, this chapter demonstrated that the dynamics of the natural and agricultural environment do not allow for accurate snapshot appraisals of land degradation (see also Scoones and Toulmin 1999). Rainfall, cultivated areas, yields, and land management all fluctuate from year to year and on the long run. Typical measurement programs have a duration of 2 to 5 years, nutrient budgets focus on a "one-year cycle", and the availability of accurate agricultural statistics usually leaves much to be desired. With

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[100] Lack of evidence of widespread land degradation does not suggest that there are no localized spots of severe degradation, neither does it suggest that the soils in Burkina Faso are so rich that farmers should never have problems to make ends meet.

these conditions in mind and the fact that multiple proxies (including social ones such as labor) are required to pin down a productivity decline as soil degradation, environmental sustainability is much more difficult to assess than is generally realized. For relevant assessments in the West African context, budgetary balances, as they are often used to determine environmental sustainability need to be extended to cover the dynamics of long-term processes (Niemeijer 1996; Scoones and Toulmin 1998; Leach *et al.* 1999). This will require, among others, the incorporation of longer time series of agricultural statistics (e.g., cultivated areas, yields), environmental data (e.g., rainfall, soil fertility), and management data (e.g., soil and water conservation practices, tillage). Results also need to be validated against such data to make sure that estimations capture reality. This should also serve as a stimulus to deepen the insight into fundamental relations between soil fertility and productivity, the basis on which any critical assessment of soil degradation rests. Finally, a major challenge will be to incorporate the effects of farmers' management practices (including their social and institutional dimension) in estimating soil loss, yield trends and nutrient budgets. In the subsequent chapters we hope to make a contribution concerning this issue by providing some more insights into these management practices and their changes over time.

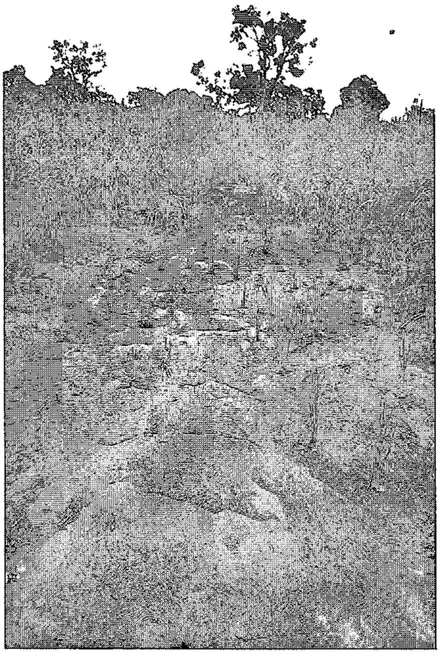

Plate IV. Localized effects of soil erosion

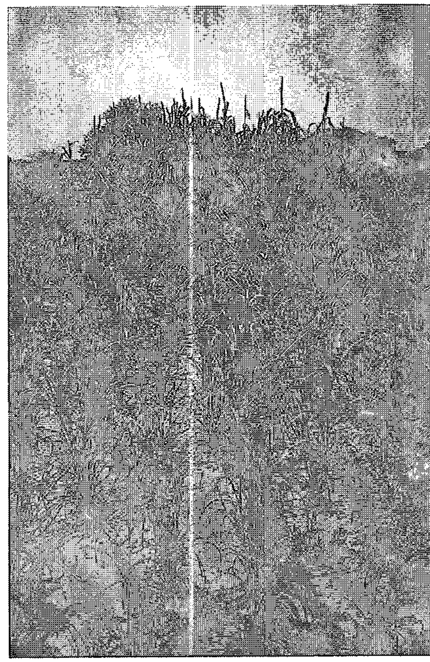

Plate V. Soil spatial variability reflected in a millet crop: location where a shrub was burned

Plate VI. Landscape near Samboanli with cleared fields in the foreground

6. Farmers' knowledge and the conservation of the soil

> "Translation," here, is not a simple recasting of others' ways of putting things in terms of our own ways of putting them (that is the kind in which things get lost), but displaying the logic of their ways of putting them in the locutions of ours. (Geertz 1983: 10)

In the previous chapter it was argued that there is no evidence of widespread land degradation in eastern Burkina Faso despite a strong population growth and a considerable expansion of cultivated area. A detailed analysis of soil samples from the research villages demonstrated the effectiveness of local land husbandry practices in maintaining the soil's chemical fertility. This finding is surprising in light of the often mentioned lack of awareness among farmers of land degradation processes, the disintegration of "traditional" farming practices, the abandonment of indigenous soil and water conservation techniques, and the inappropriateness or insufficiency of "traditional" farming practices under increased population pressure (Reij 1983; Vierich and Stoop 1990; Vlaar 1992; Lindskog and Tengberg 1994; Breman 1998; de Graaff 1998). These trends have also been mentioned in reference to eastern Burkina Faso (INERA 1993; APRG n.d.). The question is whether these trends reflect reality or whether they are rather a reflection of a lack of understanding of local knowledge[101] and farming practices in scientific and development circles. In the present chapter this question is addressed from a technology perspective, whereas chapters 7 and 8 place the local land use practices in a wider societal context.

The chapter begins, in section 6.1, with a discussion of the difficulties involved in studying farmers' knowledge and technologies as they relate to soil and water conservation. Section 6.2 presents the local soil nomenclature and discusses farmers' theories on soil and soil processes, in relation to crop cultivation. This is followed by section 6.3 on the local soil and water conservation practices. Section 6.4 discusses how farmers apply their knowledge and technologies to manage their fields in response to changing soil fertility.

[101] This chapter uses the terms local knowledge and farmers' knowledge to refer to whatwas called indigenous knowledge in chapter 2. That chapter used the term indigenous knowledge in the context of the discussion of our analytical framework because that is still the most widely used term in the literature. Use of the term is, however, not undisputed, for various reasons including it's possible connotation of backwardness and the suggestion it implies that it has all been locally developed without outside influences (e.g., Talawar 1996; Barrera-Bassols and Zinck 2000). Though not necessarily ideal, local knowledge and farmers' knowledge have less of these connotations.

Finally, in the last section some conclusions are drawn on the importance of understanding local management practices.

6.1 The study of farmers' knowledge

Until the 1980s there were relatively few studies concerned with farmers' knowledge as it applied to agriculture, soils, and soil fertility (as can be seen from recent bibliographies such as Talawar 1996; Barrera-Bassols and Zinck 2000). Some of the most notable exceptions are Leakey (1936), Conklin (1954) and de Schlippe (1956). However, numerous studies have appeared in the last 20 years that have provided a wealth of information ranging from local soil classifications to local soil and water conservation practices. As a rule they seem, however, not to have been able to convince skeptic technical and natural scientists (e.g., Vlaar 1992; Breman 1998) that this knowledge and these technologies may be adequate to cope with the increased pressures on the agro-ecosystems from which farmers derive their livelihood. Thus, while also technical scientists would nowadays agree that farmers possess an important body of knowledge and technologies, these are often considered inadequate or out-dated under present conditions (e.g., Vlaar 1992: 12). The question is whether this is a correct assessment of the situation or whether it points at inadequacies in the studies on local knowledge and technologies that has not allowed for a complete enough understanding. To give a first tentative answer to this question the next two sections will briefly discuss the ways in which local soil knowledge and local soil and water conservation practices have been studied.

6.1.1 Local soil knowledge

With the recent upsurge in publications on local soil knowledge, researchers from an increasing number of disciplines have become involved in, what is sometimes called, ethnopedology. This field is no longer uniquely the domain of anthropologists and geographers (e.g., Blanc-Pamard 1986; Furbee 1989; Warren 1992; Östberg 1995; WinklerPrins 1999), but studied by a variety of disciplines including soil scientists, agronomists, extension scientists, and even economists (e.g., Tabor 1990, 1992; Bellon and Taylor 1993; Brouwers 1993; de Steenhuijsen Piters 1995; Thiombiano 1995; Birmingham 1996; Sandor and Furbee 1996; Krogh and Paarup-Laursen 1997; Barrera-Bassols and Zinck 1998).

As much as there seems to be a consensus on the relevance of local soil knowledge there seems to be a lack of vision on how to use an understanding of this knowledge for practical purposes (e.g., planning, agricultural extension). This is probably reflective of the exploratory phase in which most of the ethnopedological research still finds itself. The prime concern of the majority of these studies ranges from "what are the local soil names?" to "how do farmers arrange those names in a taxonomy?" and, finally, "how does the local taxonomy relate to scientific concepts and taxonomies?" (see also Talawar 1996). While some studies focus on conceptual differences between local and scientific taxonomies, an increasing number of studies focus on the correlation of local soil knowledge with scientific indicators (Talawar 1996; WinklerPrins 1999). In both cases, the main objective is apparently to make local soil knowledge scientifically acceptable. In the first case by showing that conceptual differences prevent direct correlation. In the second case by proving the relevance of local taxonomies precisely by their correlation with science.

The main factor impeding effective use of local soil knowledge is that the majority of ethnopedological studies still focus on taxonomies (Talawar 1996). A focus that ethnopedology inherited from its language-centered ethnoscience and linguistic anthropology roots (see D'Andrade 1995). Local soil taxonomies have two problems that hamper their utility.

Firstly, as more disciplines became involved in ethnopedology, the tools used to elicit such local taxonomies became more varied and for the majority of the publications it is doubtful whether the taxonomies represent the emic (insiders') perspective (Niemeijer 1995).[102] More traditional ethnoscience tools such as pile sorts and triadic sorting tasks (Furbee 1989; Bernard 1994) have often been replaced by group interviews and field identification of soil types (e.g., Osunda 1988). While the latter help in getting a better understanding of the characteristics of local soil types they provide little support for obtaining an emic taxonomy. Researchers are hampered by their own background and the scientific tendency to strive for hierarchical classifications with specific discriminating characteristics for each level in the hierarchy. In most cases the output will be a taxonomy based on a mixture of emic and etic (outsiders') perspectives which may easily confuse rather than enhance communication between farmers and development workers.

Secondly, taxonomies are static representations of knowledge. As such they tend to ignore that knowledge changes over time as a result of developments in the natural and societal context of that knowledge. A taxonomy always reflects certain conceptual or utilitarian values. As those values change, this will resonate in the organization of the taxonomy. When new crops are cultivated different soil characteristics may become the most important discriminating factors between soil types. When different landforms are brought into production the number of distinguished soil types may increase in those areas.

Given the limitations of soil taxonomies, it is doubtful whether they represent the most useful aspect of local soil knowledge (Talawar 1996). Good local soil taxonomies are hard to collect and their generalizability remains dubious. It is necessary to move towards an understanding of how farmers use their soil knowledge for land management (WinklerPrins 1999). For this purpose it is much more relevant to understand farmer's theories of soil: the processes of change and the cause and effect relations that they recognize and base their agricultural decisions on (Östberg 1995; Mazzucato and Niemeijer 1998). In this context soil names and an understanding of their characteristics are important because they aid communication, yet an emic soil taxonomy is not required. It is this latter approach that will be followed in the present chapter.

6.1.2 Local soil and water conservation practices

Parallel to the attention for local soil knowledge a (partly) separate body of studies emerged

[102] For an explanation of the origins of the terms emic and etic see D'Andrade (1995: 18-19) or Bernard (1994: 238-239).

on local soil and water conservation practices. Having observed the failure of the large-scale top-down soil and water conservation interventions that took place in Africa during the 1960s and 1970s (see the introduction to this study) it was concluded by several researchers (e.g., Marchal 1979; Reij 1983; Marchal 1986) that a different approach was required. One more adapted to the conditions of small-scale farming (Reijntjes *et al.* 1992). Inspiration for such a new approach was sought in the soil and water conservation practices of the African farmers themselves. It was soon noted that there was a wealth of local practices that could be either reinforced through development support or be used as a source for technical solutions in other areas (e.g., Pacey and Cullis 1986; Reij *et al.* 1986; Reij *et al.* 1988; Reij 1991; van Dijk and Mohamed Hassan Amhed 1993; Reij *et al.* 1996).

These studies on local soil and water conservation practices have been instrumental in making policymakers and technicians aware of the value of local knowledge and practices, as well as in contributing to an increased empowerment of local land users in the development process. They, however, also suffer from two important limitations.

Just as there has been a tendency to focus interventions on mechanical technologies such as stone bunds and permeable infiltration dams, studies of local soil and water conservation practices also tend to focus on what is sometimes called ethno-engineering (Reij 1991), i.e., practices that involve mechanical structures to retain water or reduce soil erosion. In recent years though, there is an increasing attention for agronomic and biological practices such as mulching (Slingerland 1996; Slingerland and Masdewel 1996; Defoer *et al.* 1998; Hien *et al.* 1998; Lamers *et al.* 1998).

As was argued in chapter 2, most studies on local soil and water conservation have a tendency to focus on static descriptions of a particular state of technology use. Such descriptions generally provide too little information to understand how the technologies are embedded in the local society and the physical environment. This makes it difficult to use these descriptions as a basis for development interventions in the region itself, or to extend the practices to other regions, with different natural and socio-economic conditions. More important than the practices themselves is the interplay between knowledge and practices that takes place as farmers adapt these through experimentation to changing circumstances (Niemeijer 1999). It is thus more important to study the reasoning behind the use of soil and water conservation practice than describe in detail their (physical) attributes.

6.1.3 Local land management

Given the static and descriptive approach that has often been taken in studies on local soil knowledge and local soil and water conservation technologies, it is not surprising that many scientists and development workers have not been convinced of their potential to cope with changing circumstances. It is therefore important not to present, or see, local knowledge as an achievement of the past, but "as a living resource that is constantly re-invented" (Röling and Brouwers 1999: 147). Without the experimentation and adaptation that farmers undertake, their knowledge and technologies would indeed soon be out-dated, given the changing social and environmental contexts (some of which we have seen in chapters 4 and 5). The prime focus of study should thus not be the details of the local soil taxonomy or the exact length and height of the erosion reducing barriers on a field, but the ideas and concepts behind the decisions that determine how the soils are used and why a barrier is constructed on one field and not on another. This will allow a much better informed retrospective, but also prospective, assessment of the use and effectiveness of local soil and water conservation practices.

It is this kind of approach that will be taken here. The soils will be discussed, and technologies will be described, but the emphasis will be on how and why they are used, as well as how their use changed over time. This chapter will look at these issues from a technical and local knowledge perspective. Chapters 7 and 8 will take this approach one step further by placing land use and agricultural decisions within the broader context of social institutions.

6.2 Gourmantché theories of soil in relation to agriculture

To understand local land husbandry practices, and especially those related to soil and water conservation, it is important to acquire insight in local perceptions related to soils, their use, and their fertility. This will also help in answering the earlier mentioned question, whether farmers are insufficiently aware of the processes of land degradation and their role in these processes, as is sometimes suggested. Lindskog and Tengberg (1994), for example, suggest that the Fulbe in northern Burkina Faso have detailed knowledge of the symptoms of land degradation, but fail to recognize the link with causative factors, such as climatic change and human action.

This section discusses the Gourmantché theories of soil and how they relate to western scientific concepts. There are differences between the knowledge of individuals and in the way they express this knowledge. These differences relate to differences in gender, wealth, individual specializations, etc. What will be presented here is an assembly of knowledge of men and women who were interviewed and thus represents a cumulative knowledge, rather than any one individual's knowledge.

It should also be noted that the study of a local soil knowledge system (at least that of the Gourmantché) is very difficult as it operates at the intersection of linguistics, anthropology, pedology, biology, and agronomy. In addition, researchers are confronted with substantial differences between what is said by farmers in a theoretical discussion on soils, and the daily practice as it may be observed in the field. This section should thus definitely not be considered as the last word on Gourmantché soil knowledge, as that would have required a complete study in its own right.

6.2.1 The local soil nomenclature

This section discusses the Gourmantché soil nomenclature[103] and has two objectives. Firstly, it will present the criteria on which soils are distinguished and introduce the soil names and their meaning. Secondly, it will demonstrate how difficult it can be to determine a unique emic taxonomic organization of a local soil nomenclature. A final part considers

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[103] The term nomenclature is used here instead of taxonomy or classification to make explicit that the focus is on the soil names and their characteristics rather than on the taxonomic organization.

the relation between the local soil nomenclature and scientific soil classifications and topography.

Criteria and naming

As Thiombiano (1995) rightly points out, the Gourmantché distinguish soils first of all on the basis of direct observable characteristics of the topsoil and the environment in which the soil is found.[104] The topographical situation and the type of vegetation are the two most important environmental characteristics taken into account, followed by activity of the soil fauna and human influence. In terms of the topsoil attributes texture, color, and gravel content are the most important characteristics. Generally speaking, all other characteristics (such as soil depth, drainage, and fertility) are deduced from this first series of characteristics (see also Thiombiano 1995). In the case of cultivated land the response of the crop is also used as an important indicator.

The importance of environmental characteristics has two important consequences for the study of the local soil classification. Farmers often find it difficult to classify soils based on soil material alone. This implies that any study based on questioning farmers on soil samples outside their context will have difficulties in obtaining more than a few soil types in the case of the Gourmantché. Another consequence is that, because of the unavoidable limitations in the communication between researchers and farmers, it is not always possible to make explicit why a seemingly similar soil receives a different name. Such a nuance in soil naming may be due to differences in the environmental setting, rather than the visible characteristics of the soil that most scientists will tend to focus on in the field. In this study such a problem was experienced with the distinction made by farmers between three types of sandy soils referred to in terms of white, red, and black sandy soil. While it was very difficult to observe clear differences in the field in terms of color or texture, farmers argued that especially the black sandy soil was considerably more fertile than the white one because of a better consistence and a higher organic matter content. Laboratory analyses indeed revealed important (but not significant) differences in chemical fertility between the different sandy soils. This suggests that the distinction made by farmers is important, but probably largely based on environmental characteristics rather than on directly observable properties of the soil itself. This may also explain why none of the earlier studies on the Gourmantché soil classification recognizes these different types of sandy soil (e.g., Swanson 1979b; Müller-Haude 1995; Thiombiano 1995; Müller-Haude 1998). In other words, the use of environmental characteristics to distinguish between different but alike soils may present a problem for ethnopedological studies that are primarily based on farmers' identification of soils in the field (such as the studies by Thiombiano and Müller-Haude), rather than on ethno-science tools (see Bernard (1994) for a discussion of such tools).

The importance of topographic or physiographic characteristics in distinguishing between soils is probably also one of the reasons why farmers often use a single term to

[104] Thiombiano (1995) who studied both the Gourmantché and Mossi soil classification found no differences in this sense between the classifications of these ethnic groups.

denote a specific landform and a soil type at once. A clear distinction between the two, as given by Swanson (1979b), who distinguishes between what he calls "surface features" and soils, was not found in the research villages. In conversation a term such as *gbangbanli*, which refers to sloping or higher land according to Swanson (1979b), may be used by farmers to refer to a sloping or elevated area, an elevated part of a field, or to the type of soil found on higher land (usually lateritic soil). Likewise, soils with a similar texture, structure, and color will often carry a different name if found on higher land rather than a flood plain or bottomland. This is primarily because the Gourmantché, given the relatively dry climate, consider drainage and moisture availability as some of the most important soil properties for agriculture (Semmel 1992; Müller-Haude 1995; Müller-Haude 1998). Drainage and moisture availability of similarly textured soils are largely determined by geomorphology.

Environmental characteristics, though very important, are not the only basis on which soils are named. Thiombiano (1995), a Gourmantché soil scientist, notes that soil names are based on multiple criteria including topography, texture, color, and gravel content and will often be named after the one or two most dominant characteristics. In an attempt to determine the semantic ordering applied by farmers to the soil names collected in a free-listing exercise in the two research villages, pile sorts were done (see section 3.4.1 for these methods). The results were very different for each of the farmer groups with which the exercise was conducted. One group focused the grouping of soils on the potential for agriculture, another on the geomorphological and genetic relations between the soils, while a third group applied different criteria to different groups (agricultural potential, drainage ways, utility for handicraft, etc.). This implies that farmers consider the relationship between soils as multi-dimensional rather than strictly hierarchical (see also Thiombiano 1995). Depending on the context, soils can be grouped in various ways. The result of some triadic tests (see section 3.4.1 for this method) further confirm this image. When comparing triads of soil names farmers may use very different criteria of similarity and difference for each of the triads, even where 2 of the 3 soil names are identical. Based on the pile and triadic sorting, there is no evidence that there exists a unique, multi-level, hierarchical taxonomic ordering for all the different local soil names, similar to those used in scientific soil classifications. This is in agreement with the earlier studies on Gourmantché soil names by Swanson (1979b), Thiombiano (1995), and Müller-Haude (1995), who all refrain from hierarchically ordering the soils. It is also in agreement with the observation of WinklerPrins (1999: 153) that, more in general, local soil classifications "tend to exhibit nonexclusive taxonomic relations".

The wide range of criteria farmers use to determine soil names is also reflected in the description column of table 6.1, which lists the soil names collected in the research villages.[105] The table also provides a comparison with the studies by Swanson (1979b), Thiombiano (1995), and Müller-Haude (1995). Swanson collected information from various parts of the eastern region. Thiombiano focussed on two toposequences near Fada N'Gourma, while Müller-Haude's study is limited to the Gobnangou area in the

[105] The list does not include intergrades between different soil types (which are referred to by combining two names).

southeastern part of Tapoa province. This is the only mountainous part of the eastern region and it is therefore not always possible to correlate his findings with those in the research villages.

Table 6.1 Gourmantché soil names in Pentouangou and Samboanli and correlation with Swanson (1979b), Thiombiano (1995), and Müller-Haude (1995)

Pentouangou[a]	Samboanli[a,b]	Swanson (1979b)[c]	Müller-Haude (1995)	Thiombiano (1995)[c]	Description	Cultivable
			Shallow soils			
juaali	juali	-	-	djoali (L)	hill	no
juaboanli	"	-	-	djouaboanli	black hill	no
juapienga	"	-	-	djoapienli	white hill	no
tangu	"	-	-	-	rock outcrop	no
tankoali		-	-	-	denuded red, sandy, gravelly soil	no
tiaalu	"	otialu (L)	tialu	-	(lateritic) rock outcrop with some soil in the depressions	no
malitan-cianciagu	"	-	-	-	water does not infiltrate, lateritic rock near surface	no
			Lateritic soils			
tancagu*	tancadigu*	tancaaga	tintancaga	tanpkiaku	red gravelly soil	yes
gbangbana*	gbangbanli*	gbangbanli (L)	-	-	lateritic soil on sloping or elevated land	some
			Sandy soils			
tanbiima	tanbiima	tintanbiima	tintanbima	tanbima	sand	yes
tanbipiema*	tanbipieni*	-	-	-	white sand	yes
tanbimoanli*	tanbimoanli*	-	-	-	red sand	some
tanbiboama*	tanbiboanli*	-	-	-	black sand	yes
tideriboandi	-	-	-	-	sandy soil at beginning of water course	no
			Stream and bottomland soils			
fuaano*	fuanu*	fuanu (L)	-	foanu (L)	soil of ephemeral drainage way	yes
baagu*	baagu*	baagu (L)	baagu	baagu (L)	bottomland, flood plain	yes
laagu					swamp soil	some
balogili	"	boanbala (L)	buanbalgu	-	flood plain soil on land bordering riverbed	yes
tabi juaanu	-	-	-	-	hard, sandy bottomland soil	yes
kpentanpiili	-	-	-	-	white, sandy bottomland to the side of drainage center	some
cakpenkpegu	"	-	-	-	soil of filled in old wells in bottomland	some
boangu / kpenu	"	-	-	-	drainage coarse of bottomland	no

Continued on next page

Table 6.1 – ***Continued***

Pentouangou[a]	Samboanli[a,b]	Swanson (1979b)[c]	Müller-Haude (1995)	Thiombiano (1995)[c]	Description	Cultivable
			Stream and bottomland soils			
kpenboanu	-	-	-	-	dark, muddy, drainage center soil	no
kpenkada	-	-	-	-	soil at crossing of water courses	no
kpenpienu	-	-	-	-	White, sandy, drainage center soil	no
			Loamy and clayey soils			
tinboanli*	tinboangu*	tinboanga	tinbuanli		dark loamy soil	yes
tinmoanli	tinmoanga	tinmoanga	tinmuanga	tinmoanli	red loamy soil	yes
muanli	"	-	muanli	-	ash white clay soil used as paint	no
bola	-	-	bolbuonli	-	heavy clay soil with vertic properties such as sink holes and cracks	yes
tinjuabili	boali*	boalli	tinbisimbili / tintabili	libwali	red or black sticky loamy soil	yes
yuagu	yoagu	-	-	-	red or black clay used for pottery (found outside water course)	no
boaligu	-	obualigu	bualgu	boalgou	clay used for constructing huts at beginning of water course	yes
			Soils with impermeable layer			
bundoba	-	-	-	-	bare land, water does not infiltrate because of an impermeable layer, but may appear at surface during dry season (natural well)	no
kpada	-	-	-	-	bare land, water does not infiltrate because of an impermeable clay layer; sandy topsoil is washed away	no
ñinmuali*	ñinmuali*	-	pugu	-	soil with impermeable layer, water surfaces during rainy season	yes
-	wagili*	-	-	-	poor soil, with impermeable layer that prevents infiltration	yes
			Salty soils			
liangu	-	-	-	-	glistening soil used as a salt lick by animals	no
liaanli	lianli*	lilianli	lianli	-	salty soil used as a salt lick by animals	no

Continued on next page

Table 6.1 – ***Continued***

Pentouangou[a]	Samboanli[a,b]	Swanson (1979b)[c]	Müller-Haude (1995)	Thiombiano (1995)[c]	Description	Culti-vable
			Salty soils			
kpankpatan-buagu	-	-	kpamkpagu	-	salty soil with stones in them suitable to make bracelets	no
			Anthropogenic soils			
dagbena	-	-	-	-	fertile soil at site of old settlement	yes
konli	-	-	-	-	very fertile soil at site of old settlement abandoned so long ago that thorn trees have become very dense	yes
tanbuogu*	"	-	-	timbengu	fertile soil formed in depression created by digging up clay for bricks to use in construction	yes
			Special soil and soil states			
buoogu	"	tinbuooli (L)	-	-	fertile soil formed in natural depression	yes
tuuli*	"	-	-	baboatandi	fertile soil formed on old termite mounts	yes
tinyuli	"	-	-	-	most fertile site of a field, usually where a tree stood or animals slept	yes
naluogu	-	-	-	-	fertile soil where cattle used to rest	yes
pepeli*	penpeligu*	-	pempelgu	penpelgu	denuded soil where water does not infiltrate because of soil crusting and hard-setting	no
tinkpienga	tinkpienga	-	-	-	dead soil	no
tinpienga	tinpienga	tinpienga	tinpienga	-	white soil	yes
jualioangu	-	-	-	-	soil of at descent of a hill, beginning of surface flow	yes
tindigu	-	-	-	-	eroding soil between an elevation and depression, beginning of surface flow	no

Sources: Free listing, pile sorts and field visits with farmers in Pentouangou and Samboanli; Swanson (1979b), Thiombiano (1995), and Müller-Haude (1995).

Note: The most likely matches between soil names are based on the similarity in the names as well as the description given by the farmers or authors. A hyphen (-) indicates the soil was not mentioned.

[a]An asterisk (*) indicates that the soil was encountered on one or more occasions in the field.

[b]Double quotation marks (") indicate that a soil was not mentioned in Samboanli, but upon questioning was recognized.

[c]Where Swanson or Thiombiano mention a name as a landform rather than as a soil type this is indicated by a capital (L) between brackets behind the name.

As can be seen in table 6.1, almost 50 different soil types were mentioned in Pentouangou, while the number was considerably smaller in Samboanli. This may be due to differences in the natural setting, and the relatively large territory, with substantial bottomlands and larger water-courses, of Pentouangou compared with Samboanli. It may, however, also be related to how the free-listing exercises were interpreted by the informants in the different villages. During soil sampling on agricultural fields and uncultivated (but cultivable) land (see section 3.5.3 for the methodology) a much smaller number of these soils was identified by farmers. In taking some 70 soil samples in each village, 10 different soil names were mentioned in Pentouangou and 12 different soil names in Samboanli.[106]

Note that despite some differences in dialect[107] the soils most often encountered in the research villages have an equivalent with Swanson (1979b), Thiombiano (1995) and Müller-Haude (1995). This indicates that these major soil types are encountered and known throughout the eastern region by, with a few exceptions, very similar names. Not included in the table are three soil types mentioned by Müller-Haude (1995) for which no equivalent in the research villages was found. This, together with the fact that for quite a number of soils mentioned in Pentouangou no equivalent was found with the other studies, indicates how difficult it can be to collect a complete list of all soils known to an ethnic groups.

The local soil nomenclature in relation to scientific classifications and topography

Many ethnopedological studies attempt to correlate local soil types with scientific classifications (Talawar 1996). In practice this is extremely difficult because the criteria on which soils are classified often differ considerably. Local soil classifications tend to be utilitarian and based on visible properties, while scientific classifications are often based on issues such as soil genesis and additional laboratory determined criteria (such as the USDA Soil Taxonomy or the FAO classification, Landon 1991). An additional problem in the case of the Gourmantché soil nomenclature is its reliance on environmental characteristics, while scientific classifications are based on the properties of the soil only. Table 6.2 shows that, as a consequence of these issues, local soil types do not have one to one equivalents in either the French classification (CPCS 1967) or that of the FAO (1988).

Similar problems occur if it is attempted to determine the spatial correlation between local soil types and different landforms. Most of the eastern region consists of flat, slightly sloping or gently undulating land. For the research villages this covers some 75% of the territory (see table 6.6 later in this chapter). As a consequence, the spatial patterns of soils are often more related to micro-topography than to macro-topography. An idealized toposequence such as depicted in figure 6.1 is thus more illustrative for some general

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[106] It is possible that the large number of soils that were mentioned during the free listing exercise in Pentouangou is more a reflection of the effort of the informants (to come up with any soil name they could think of), rather than an indication that Pentouangou farmers regularly distinguish more soil types than farmers in Samboanli. As can be seen from table 6.1, an important number of soils mentioned only in Pentouangou during the free-listing exercises are also known in Samboanli.

[107] There are also variations in spelling. None of the sources follows the official Gourmantchema alphabet; neither is this done here, because many soil names are not found in a dictionary or the dictionary does not cover the variations in dialect.

Table 6.2 Correlation of local names of the main soil types with French and FAO soil classifications (based on 13 profiles in the research villages)

Local soil name	French classification (CPCS 1967)	FAO (1988) classification
Baagu	Sol peu évolué hydromorphe	Eutric Regosol
	Sol brun euthrophe	Gleyic Lixisol
Ñinmoali	Sol peu évolué d'apport colluvial sur brun euthrophe	Eutric Planosol
Tanbipiema / tanbipieni	Sol peu évolué d'apport colluvial/alluvial	Eutric Regosol
	Sol ferrugineux lessivé hydromorphe	Albic Lixisol
Tanbiboama / tanbiboanli	Ferrugineux lessivé	Haplic Lixisol
	Sol peu évolué d'apport colluvial	Haplic Arenosol
Tancagu	Sol ferrugineux lessivé à tâches et concrétions	Feric Lixisol
	Sol ferrugineux lessivé induré moyennement	Eutric Leptosol
Tinboanli / tinboangu	Sol ferrugineux lessivé à tâches et concrétions	Haplic Acrisol
	Sol brun euthrophe ferruginisé	Haplic Lixisol
Tinjuabili / boali	Sol brun euthrophe ferruginisé	Ferric Lixisol
Tinwagili	Sol brun euthrophe ferruginisé	Stagnic Lixisol

Source: Classification of 6 profiles in Pentouangou and 7 profiles in Samboanli.

tendencies in relation to the most common soils than that it provides any practical information on what soil types to expect where on the gently sloping to flat landforms.

While the attention given to topography in the Gourmantché soil nomenclature differs from most scientific soil classifications this does not imply that there is no place for topography in the scientific perception of soils. To the contrary, the catena concept, whereby soil sequences are studied in relation to particular slope forms and landscapes, is widely applied in soil science and also emphasizes the interaction between soils and landforms (Gerrard 1992). The importance of the interaction between soils and geomorphology has in the 1970s even led to the development of a new discipline: soil geomorphology, which studies "the genetic relationships of soils and landforms" (Gerrard 1992: 2). In other words, the importance of topography for soil formation is recognized by western science, it is however, only to a lesser extent incorporated into the soil nomenclature than is the case for the Gourmantché.

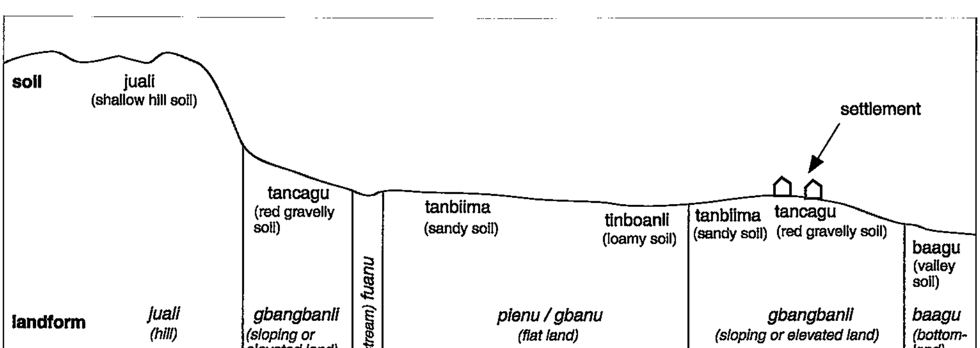

Figure 6.1. Sketch of an idealized toposequence showing the main local soil types and landforms

6.2.2 *Processes of soil formation and degradation*

As was argued earlier, a soil nomenclature is but one way of looking at local soil knowledge, and by far the least interesting. This section and those that follow will consider the theoretical dimensions of local soil knowledge. What are the theories that farmers have concerning soil processes and soil fertility, and are they aware of the risks of land degradation?

Before discussing the local soil theories, it is important to note that farmers derive most of their soil knowledge from three types of experiences: crop cultivation, grave digging, and well digging. Through crop cultivation they gain primarily insight in the topsoil, while through grave and well digging they gain insight in the subsoil and deeper layers.

According to farmers the landscape is shaped by erosion, sedimentation, and the transformation of organic matter. Through water erosion, which is called *ñinkoadima* or *ñinkuadigu* (lit. scraping water) hills become smaller and valleys are formed. Sediment is said to be transported from those hills down to the valleys and from there to far away rivers and lakes. Farmers explain that near the hills gravely soils are formed and, as one follows the course of the water, the soils are less gravely and more sandy, to become loamy or even clayey in the bottomlands. In some areas soils "shrink" because of erosion while in other areas they grow through sedimentation and the decomposition of organic matter from leaves and grasses. One of the informants, Yombo Thiombiano explained it like this:[108] "Often when you dig a hole you will encounter a piece of pottery or an object that someone had dropped. Maybe it fell in a hole, but it wasn't deep, now you will find that it is deeper. That means that the soil has grown."

Erosion not only shapes the landscape but it also influences soil productivity. Farmers often point out those parts of their fields where fertile topsoil is washed away by sheet erosion to lower lying parts of the field. Where erosion is serious, farmers explain, gullies, called *ñinsanu* (lit. water way), are formed that expose the roots of the crop. Eventually the topsoil (*tinga*) will be gone and the gravely subsoil (*tingini*) will become exposed. One farmer explained that especially with plowing you need to be careful, because if wrongly practiced the gravely subsoil will come up within 3 years. Another informant explained that in all soils there is gravel at a certain depth. In some this is at or close to the surface in others it is deeper. Water erosion will expose the gravel in some areas while the gravel will be buried deeper in sedimentation sites. Water also deposits sand on the soil. Sand can be in the soil as well, but if you dig deep you will not find sand anymore, you will find earth (loam or clay). Water can also deposit dark earth on top of sand, and this will then slowly mix. In other cases, water may wash the sand and it will become white: the dirt will wash off. Though much less an issue in the research area than water erosion, also wind erosion is mentioned by some farmers as a source of soil loss (see Sterk and Haigis (1998) on farmer perception of wind erosion processes in more northern areas in neighboring Niger).

Another soil forming process is the accumulation and decomposition of organic matter on the soil surface. As will be shown in the next section, farmers make a distinction

[108] Interview on 15 October 1996, Pentouangou.

between fresh and decomposing organic matter (e.g., manure, debris) on the one hand, and soil organic matter on the other hand. The accumulation of soil organic matter (SOM) is said to make the soil grow. However, informants explain, the soil does not accumulate SOM indefinitely. The plants "drink" SOM in order to grow and also the soil itself consumes SOM. Yombo Thiombiano explained the latter like this: "For example, the stones that are on the soil, they do not disintegrate, but if you dig deep, and you put a stone there and come back after many years you will find that it has disintegrated. This means that the soil has consumed it. Likewise it consumes soil organic matter." This is also one of the reasons why soils are said to contain SOM only down to a certain depth. Below that, you find *tinfanga*, which means empty soil. Depending on the soil type and the vegetation the SOM limit is considered by farmers to be at a depth of 20 to 70 cm. Clayey soils are said to hold SOM much better than sandy soils.

From the foregoing it follows that the farmers' interpretation of the formation of landscapes is remarkably similar to that of Western science. More surprisingly it appears that the Gourmantché are aware of the long-term impact of slowly operating processes, such as weathering, erosion, and sedimentation, on the landscape they see today. Even though they cannot actually see the hills becoming smaller (as it is a process that operates on a geological time scale) they do realize the implication of the transportation of rocks, gravel, sand, and earth from these locations by water (something that they can observe). Similarly they realize that what may start as a gully may eventually develop into a valley. As far as soil formation and degradation are concerned, farmers recognize the impact of erosion and sedimentation as this is immediately visible in some locations and directly affects the productivity of their fields for better or worse. This awareness not only concerns gully erosion, which is not that common in the research area, but also sheet erosion. The story about the buried stone also clearly highlights that farmers are conscious of the "weathering power" of the soil.

In sum, it may be concluded that Gourmantché farmers are well aware of the potentially harmful aspects of soil erosion.

6.2.3 The Gourmantché concept of soil fertility

The Gourmantché concept of soil fertility is very much centered around soil organic matter (SOM). When asked whether a soil is good, or why one part of a field is better than another, responses will usually revolve around differences in the quantity of SOM. No reference is made to differences in the mineral constituents of a soil in terms of soil texture or mineralogical composition. Indirectly, differences in texture do play a role through the link that farmers draw between consistence and fertility. Soft soils are generally considered less fertile than hard, strong soils.[109] This consistence is considered both as a given property dependent on the soil type and as a dynamic property based on the amount of organic matter and the impact of tillage.

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[109] Krogh and Paarup-Laursen (1997) noted a similar view among the Fulbe of northern Burkina Faso, who also speak of a soft soil when referring to a sandy soil of low fertility.

Farmers use the words *sensendi* or *bugidi* in Gourma province and *biliga* in Gnagna province when referring to soil organic matter. It is very difficult to get a clear understanding of how these words are defined because they are often used interchangeably with some of the specific terms for organic matter discussed in the next paragraph. In explaining the meaning of these words farmers refer to algae, to animal manure, and to the process of rotting and decomposition. From these explanations it is clear that they make a distinction between fresh and decomposing organic matter on top of the soil and soil organic matter inside the soil. When they speak of the *sensendi* or *biliga* of the soil they refer to a highly transformed form of organic matter that is no longer visible with the bare eye but does give the soil a darker color. In that sense, their terms probably come close to the partially mineralized and humified organic matter that is known as humus. Because farmers not always use their terms in such a strict sense, the more general term soil organic matter (SOM) will be used here.

Informants recognize four main sources of SOM. There is animal manure called *jambiliga* (Gnagna) or *yanbindi* (Gourma), there are grasses (*muadu*) and leaves (*faadu*), there is organic debris (*joagindi*, *jagintu*, *baadu*, *buri*), and there are old termite mounds (*tuuli*).

Animal manure quite readily becomes SOM. How well it integrates into the soil depends on what animal it comes from and how fresh it is. Cattle dung is considered to integrate into the soil quicker than goat or sheep dung. Goat or sheep dung is therefore preferred when manure has to be transported to the field from elsewhere. Farmers explain that there is, however, less goat and sheep dung available (in terms of total volume) and that if it is possible to paddock cattle on the field this is the most effective form of fertilization. Even the urine is said to fertilize the soil.

Leaves and (dead) grasses need to be in contact with the soil and rain to rot and decompose (*beri*). In this way, farmers explain, they become organic debris and eventually SOM. The organic debris, such as household refuse and crop processing residue, has to be piled together on the soil so that when it is moistened by rain it will rot and become SOM.

Old termite mounds are said to be rich in SOM because the termites have brought organic debris and leaves and grasses to their home. Termites are also considered valuable in transforming the crop residue that is left on the field after the harvest, into SOM before the new rains (plate VII).

Soil organic matter is considered vital for crop cultivation. A soil that has lost all its SOM through years of continuous cultivation becomes *tinkpienga*, a dead soil. Farmers say that without SOM plants may germinate but they will not grow well. As was mentioned earlier, SOM is also considered important for the physical structure and consistence of the soil. A SOM-rich soil will be hard and strong, one without will be soft and weak, and the plants will be easily uprooted by wind. An overexploited soil will become denuded and crusted (*penpeligu*). Such a soil can only be regenerated through the application of organic matter in the form of, for example, straw or grass mulches. Still, as several farmers explained, it is also possible to apply too much manure or organic matter to a field.[110] On a rich soil, crops will begin to grow very well, but if the rains fall short, they may not develop

[110] Krogh and Paarup-Laursen (1997) also mention this concern for the Fulbe of northern Burkina Faso.

a lot of grains towards the end of the season. Similarly, it is often said that groundnuts will not produce a lot of grains if the soil is too fertile.

Farmers also hold ideas on what they call white man's *sensendi/biliga*, i.e., mineral fertilizer. Few, if any, farmers use this on a regular basis so that their ideas are mostly based on hearsay and observations of other people who have tried it.[111] A quite widely held misconception among local farmers is that mineral fertilizer can completely replace organic matter; that they are interchangeable in other words.[112] Still, a number of farmers presented more nuanced views. One farmer explained that black people's fertilizer is better than white people's fertilizer because the first has an effect for multiple years, while the second needs to be applied on a yearly basis. In addition, he said, it is easy to use too much of white people's fertilizer and your plants will not reach maturity or too little fertilizer and it will not have any effect. Another farmer adds that organic and mineral fertilizer support each other, because the organic matter takes care of humidity. Mineral fertilizer alone will lead plants to dry-out. Another farmer, Djalambiga Lankoandé, however, pointed out that you should take care in using both types of fertilizer at the same time:[113] "Too much fertilizer is not good, because, if one eats and has enough and nevertheless continues to eat, the stomach will explode." This probably refers to the earlier mentioned problem of too much fertility and too little rain.

As far as soil fertility is concerned there are again clear similarities between explanations of the farmers and the views of Western science. Just to mention a few of these: the role of water in the decomposition of organic matter, the positive effect of SOM on soil structure and consistence, SOM as the source of vital plant nutrients (nitrogen and organic phosphorus, but also in terms of the capacity to exchange cations), and the effectiveness of livestock paddocking as fertilizing measure. To take the latter point as an example, research confirms the observation of informants that urine is an important source of soil fertility and that livestock paddocking is more effective in fertilizing the soil than manure transport. Powell and Valentin (1998), for instance, note that corralling has large positive effects on yields that may last two to three cropping seasons and through urine improves soil pH and the release of soil phosphorus for plant growth. They also note that, as was argued by Gourmantché farmers, manure decomposes and releases nutrients faster than biomass, and in a pattern that coincides closely with plant nutrient demands (Powell and Valentin 1998: 322). Also the argument of farmers that goat and sheep manure decomposes slower than cattle manure and is therefore more suitable if manure has to be transported to the field is confirmed by research (Brouwer and Powell 1998). Also the importance of termites, especially in the dry Sahelian climate, in transforming crop residue into plant available nutrients leading to increased crop yields, is confirmed by research (Mando 1997; Mando and Brussaard 1999).

[111] None of the farmers who participated in the village survey (see chapter 3) mentioned the use of mineral fertilizers.

[112] This misconception might be related to the way mineral fertilizers have been introduced in the area by the agricultural extension service.

[113] Interview on 19 February 1997, Samboanli.

At first sight there is one striking difference in perception between farmers and scientists: Gourmantché farmers seem to see chemical soil fertility mainly in terms of organic matter, whereas agronomists and soil scientists put a lot of emphasis on the mineral component (mainly in terms of NPK, i.e., nitrogen, phosphorus and potassium). This difference in perception is however getting smaller as scientists are becoming more and more aware of the importance of organic matter. For instance, Breman (1998) argues the primordial role of organic matter in soil fertility restoration. The importance attributed by farmers to organic matter was also found in a recent survey in the Mid-west of the USA, where farmers put organic matter on the first place when ranking soil health indicators (Romig *et al.* 1995). Several reason for the Gourmantché farmers' emphasis on SOM as the prime source of soil fertility may be postulated. Firstly, the organic component of chemical soil fertility is something they can manipulate and manage through biological management practices (e.g., restitution of crop residue, application of mulches, and paddocking of cattle), whereas traditionally they have not had access to means to manipulate the mineral component of chemical soil fertility (i.e., mineral fertilizer).[114] In this light, the emphasis on the organic component in discussions on soil fertility, and the virtual equalization of soil fertility to SOM, is not surprising. Secondly, it must be noted that the soils in this part of Africa are generally very low in mineral soil fertility (Kowal and Kassam 1978; Breman 1998). Therefore the organic component plays a very important role, also from the scientific perspective, in determining actual soil fertility (Stroosnijder 1992). Firstly, organic matter is highly correlated with nitrogen,[115] one of the three macro-nutrients required for crop growth. Secondly, organic matter is an important source of phosphorus.[116] Thirdly, in semi-arid West Africa organic matter is an important source of soil Cation Exchange Capacity (CEC), as many soils contain low clay percentages and the clays are often of the kaolinitic type which has a low CEC (Breman 1998). The CEC of a soil is important, because it influences the availability of plant nutrients such as potassium, calcium and magnesium. This is one of the prime reasons why, for instance, Breman (1998) notes, that without improving the organic matter status of the soil, mineral fertilizer applications are often ineffective. Finally, soil organic matter is important for the soil structural condition and stability (Hoogmoed 1999). This said, it is still a fact that from a scientific point of view non-organic soil nutrients such as potassium are very important for plant growth and only show a limited correlation with soil organic matter content.

However, on closer examination, there are indications that farmers are more aware of the mineral components than comes out when asked about a definition of soil fertility. Several farmers, for instance, explained that sorghum and millet consume different kinds of "food" and are therefore best grown in rotation. Such remarks could be referring to some kind of invisible "mineral component" of soil fertility. Another indication is that some

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[114] There is no natural rock phosphate found in or near the research villages. The commercial exploitation of rock phosphate from the Gobnangou area (southwestern corner of Tapoa province) is a relatively recent phenomenon and rock phosphate was not applied in the research villages according to the village survey.

[115] A Pearson Product-Moment Correlation of .89 was found for the 135 topsoil samples collected in this study.

[116] On the nine compound fields for which topsoil samples were collected the Pearson Product-Moment Correlation of organic matter and total phosphorus was .95, while for the village fields, bush fields, and uncultivated areas the correlation ranged from .50 to .68 (between 29 and 61 samples each).

informants explained that each soil type has a different kind of fertility and that there is a difference between the fertility of the deeper layers of the soil and that of the more superficial parts, which is based on organic matter. Also the earlier mentioned view that plants do germinate without SOM could indicate that the soil is considered to have "other kinds of food" than SOM alone. Similarly, the distinction farmers make between the effects of white people's fertilizer (mineral) and their own fertilizer (organic) might be taken as an indication that farmers are aware of other than organic aspects of soil fertility. Finally, farmers are aware of the fertility of the minerals (salts) found in certain ashes, which are referred to as potash when used for cooking.

In conclusion, farmers appear to be well aware of the processes influencing chemical and physical soil fertility. What is more, they know how to influence soil fertility through organic matter application to enhance SOM and improve soil humidity. There is some difference between farmer and scientific perceptions as to what constitutes soil fertility. Gourmantché farmers focus primarily on organic matter and the management of organic matter flows, whereas agronomists and soil scientist often focus on both the organic and mineral constituents of the soil.

6.2.4 Synthesis: land use and soil dynamics

It was shown that Gourmantché farmers have a good eye for the dynamic processes affecting soil formation and soil fertility. They are aware of the natural processes and the way in which they as land users may affect and influence these processes for worse or better. This leads to a dynamic perception of the condition and qualities of the soil.

In section 5.3.3 it was already noted that a direct link is recognized between cultivation induced alterations of the soil and the natural vegetation that is found on a soil. On long-term uncultivated land different plant species are found than on cultivated land, which again differ from those on fallow land. The floristic composition of a site is thus one of the most important factors for farmers to judge the fertility of a soil and to know when to abandon a field. Also the soil fauna is considered important in this respect. Termites were already mentioned, but also earthworms are considered an indication that a soil is fertile. Flora and fauna thus reflect the changing condition of the soil and are as such important indicators of changing soil quality.

According to the Gourmantché, the condition of a soil changes as a result of natural processes such as erosion, deposition, weathering and organic matter accumulation, as well as through human actions. The two most often mentioned human actions are livestock raising and crop cultivation. Farmers readily point out that manure is good for the soil (as long as it is not too much), but that livestock also generates a number of environmental problems. The loss of certain natural grasses as a result of livestock trampling and consumption was already mentioned in section 5.3.3. Informants in Pentouangou also point out that increased livestock numbers lead to a loss of ground cover which increases runoff and therefore soil erosion. Furthermore, livestock trampling is considered bad because it leads to soil crusting and compaction an observation that is supported by the literature (e.g., Powell and Valentin 1998). So, while most farmers consider crop residue consumption by livestock on their fields as positive and contributing to soil fertility, because of the deposited manure, they tend to evaluate the growing livestock population (chapter 4) negatively for the environment in general, as well as for fallow regeneration (except in the case of paddocking on fallows).

Also crop cultivation exerts a strong influence on the soil, according to farmers. Crops consume SOM and long-term cultivation alters the properties of a soil. With time, the soil becomes weak, because of tillage and the decreasing amount of SOM. Eventually it may become barren land if no proper management precautions are taken such as fallow or mulching. The changes caused by cultivation are so important that it leads some farmers to express them by giving a soil a different name: saying for instance that *tanbiboanli* (black sandy soil) may become *tanbipieni* (white sandy soil) if cultivated too long, and will finally end as *penpeligu* (denuded soil). Others however say that this is impossible because *tanbiboanli* differs from *tanbipieni* in more respects than a higher fertility.

Farmers also consider long-term dynamics when they speak of changing soils by explaining, for instance, that below the fertile *boali* (sticky loamy soil) lies *ñinmuali* (lit. crying water) that may surface after continued erosion. *Ñinmuali* is considered not very suitable to crop growth because sub-surface flow from nearby slopes may emerge from it's surface up to several days after a rainstorm and lead to waterlogging.

Soil qualities (the assessment of a soil characteristic as being good or bad) are also considered dynamic in the eyes of the Gourmantché. Few cultivable soils are considered inherently good. What constitutes a good soil depends first and foremost on the amount of rainfall and the macro- and micro-topography. Certain soils, such as *tancagu* (gravely soil), are considered good in wet years, others, such as *ñinmuali* and *baagu* (bottomland soil), are considered good in dry years. Some soils are considered to fare well within a broader rainfall range such as *boali* (sticky loamy soil) and *tanbiboanli* (black sand). In some cases it is the water holding capacity of the soil that determines its suitability, in other cases it's position in the landscape. Müller-Haude (1995), in his study of the Gobnangou area, also noted that the Gourmantché consider the quality of a soil in relation to a specific rainfall regime. Swanson (1979b: 8), in turn, noted that "a rainy season that was considered 'good' by one farmer can be considered 'bad' by his neighbor – the difference resting entirely on the surface feature characteristics of their respective fields." Semmel (1992) argues that the Gourmantché consider the hydrology of a soil as the most important characteristic, because soil fertility differences can be addressed by land management practices.

Soil quality is also assessed in relation to the crops one wants to grow. Where a soil scientist would tend to qualify a very fertile soil (in both chemical and physical terms) as a good soil, a Gourmantché farmer sees this primarily in terms of the crop he wants to grow. A good maize soil should indeed be very fertile, but a good groundnut soil should not be too fertile (section 6.2.3). The fact that soil qualities are assessed in relation to rainfall, topography, and crops implies that the declining rainfall levels since the wet 1950s that were noted in chapter 5, as well as the introduction of new crops (chapter 8), have led to a re-evaluation of the suitability and therefore quality of the soils. The previously under-utilized bottomlands in large parts of eastern Burkina Faso are now increasingly exploited for rice cultivation (Swanson 1979a). Soils, such as the earlier mentioned *ñinmuali*, that were considered too moist for cultivation are now increasingly used for sorghum and sometimes even millet cultivation.

While it was earlier noted that scientific and Gourmantché perceptions coincide in many ways as far as soil processes and soil fertility are concerned, they tend to diverge in the evaluation of soil properties (characteristics of the soil) and qualities. The scientific perception tends, in naming and evaluating the soil, to focus on those aspects of soils that are more or less fixed, by focusing on the subsoil (down to 120 cm) and on soil genesis. Farmers, instead, emphasize the characteristics of the topsoil and the utility for crop growth making their assessments of soils much more dynamic (Guillaud 1993). In fact, this focus on the topsoil may give the Gourmantché farmers an advantage compared with scientists when it comes to assessing the influence of land use on the condition and potential of the soil. In their assessment of the soil, farmers automatically take into account the dynamic effects of land use, whereas scientists, in for example a standard land evaluation, tend to focus on generic properties of soil types classified primarily on the basis of the properties of the B-horizon.

There is yet another way in which scientific and Gourmantché perceptions deviate. Because Gourmantché farmers emphasize the importance of organic matter for soil fertility they, contrary to nutrient depletion studies, do not seem to believe in the possibility of an irreversible loss of soil fertility (that requires mineral fertilizer to be undone). In their view, vegetation plays a primordial rule in maintaining and regenerating soil fertility. Several informants explained that decreasing rainfall levels have led to a more scanty natural vegetation that slows down the regeneration of fallows. They have no doubt that if rainfall would increase once more, this will lead to a recovery of natural vegetation and, consequently, an improvement of the soil's organic matter status and therefore it's fertility. But, and this is where the two perceptions meet again, farmers, especially in Samboanli, are concerned with the reduced fallow duration as a result of population growth and claim that this reduction leads to a soil fertility decline. Chapter 5 showed that at present there is no evidence (yet) of reduced fallow length leading to soil fertility decline. This could imply that both farmers and scientists are insufficiently aware of the degree to which reduced fallow length has been compensated for by changed agricultural practices, such as those discussed in the next section. In other words, they recognize the importance of a process (reduced fallow duration leading to soil fertility decline), but are at a loss concerning the degree to which this is compensated for by other processes (such as more intense soil and water conservation use). An alternative explanation would be that farmers speak of a fertility decline, not because soil fertility really declines, but because they need to make greater efforts to maintain fertility at the same level.

All in all, Gourmantché farmers appear not only to be well aware of the dangers of land degradation, but also to be well placed in terms of their soil knowledge to prevent degradation from taking place on their fields. This is in contrast to the popular belief that farmers are insufficiently aware of the risks of land degradation because they do not recognize processes such as sheet erosion. Kessler *et al.* (1995), for instance, note that four out of the five soil and water conservation projects they studied in the West African Sahel, engage in considerable efforts to make the population aware of the risks of desertification and land degradation. Lack of knowledge does not seem to be an issue with the Gourmantché. The question that remains however, is how this knowledge is used to achieve the kind of environmental sustainability that was demonstrated in chapter 5. This is the topic of the next sections.

6.3 Soil and water conservation practices

This section will present the soil and water conservation practices used by Gourmantché farmers in the eastern region. Aside from introducing and briefly describing the practices, this section focuses on the link between environmental knowledge and agricultural practice. An attempt will also be made to answer the question whether, as sometimes has been suggested, "traditional" soil and water conservation practices are being abandoned or whether, to the contrary, they have been adapted to changing environmental conditions and increasing population densities?

Soil and water conservation as practiced by farmers is not limited to the engineering type of measures typically focused on by research and development (e.g., Vlaar 1992; Kessler *et al.* 1995). According to Hailu and Runge-Metzger (1993) soil and water conservation practices consist of biological measures, mechanical measures, and institutional arrangements. The first category refers to particular management practices that make use of agronomic skills and biological material rather than physical structures. They will here be referred to as agronomic/biological practices[117] to emphasise the management skills involved. Mechanical practices, on the other hand, refer to practices that involve physical structures, often with a barrier function. Institutional arrangements refer to land tenure arrangements, forms of labor sharing, and so forth, that may also contribute to maintenance of soil fertility. These kind of issues are treated in chapter 8, in which the role of social institutions in agriculture is discussed.

Table 6.3 presents an overview of the soil and water conservation practices found in the eastern region. The table makes no distinction between so called "indigenous" practices and "introduced" practices, because all of the listed practices have become part of the local repertoire. As most of the practices have been known in the area for several generations it is impossible to determine what their precise origins are. There are only three practices of relatively recent nature. The first one is mulching with grasses, which according to informants was copied from farmers on the Central Plateau, where it was observed during travelling. The second one is the stone bund, a larger form of the "traditional" stone rows, and picked up from nearby villages with project intervention. It is however used sparingly and only in Samboanli, the northern research village. The last one involves the large earth bunds used on bottomlands in Pentouangou to retain water for rice cultivation. It was probably introduced to the eastern region by the agricultural extension service.

[117] The word practice instead of measure will be used in this study, because measure is a more narrow and rather technical term that focuses on problem-solving and is often used when referring to structures. The term practice, instead, is a broader term that focuses more on skills and can cover anything from structures to a particular way of weeding. Also, because it has less this association with problem-solving it can be used to refer to ways of doing things that may contribute to solving certain problems without implying that this was their (prime) objective in the first place.

Table 6.3 Soil and water conservation practices in eastern Burkina Faso

Practice	Soil and water management	Extent
	Agronomic/biological practices	
Crop sequencing	Different crops are grown throughout a field's cultivation history in response to soil fertility decline caused by crop production. The sequence usually starts with the most demanding crop and ends with crops requiring the least amount of soil fertility. Crop sequencing is usually combined with crop rotation (see below). This practice limits soil nutrient depletion.	Very widespread
Crop rotation	The crop sequencing practice (see above) includes periods in which a particular combination of crops is rotated. While a sequence may, for instance, start with three years of sorghum this may be followed with a period in which sorghum and millet are rotated on a yearly basis, to later be replaced by a groundnut-millet rotation. This practice limits soil nutrient depletion and reduces the risk of plant disease and weeds.	Very widespread
Fallowing	After a certain number of years a field is abandoned so that soil fertility can be regenerated through natural processes. Used extensively for bush fields, but not for compound fields that instead receive organic matter inputs.	Very widespread
Weeding	Weeds are removed at several stages in the growing cycle of the crop. This practice reduces moisture, nutrient, and light competition between the crop and weeds and therefore increases yield, while limiting nutrient and moisture losses. Weeds are left to decay in piles on the field as a form of compost.	Very widespread
Selective clearing	When a new field is cleared or an old fallow is taken into production again, a number of trees and shrubs are left on the field because of their edible fruits, medicinal properties, or other qualities. In addition, when removed, shrubs and trees are usually cut about half a meter above the soil surface to facilitate regeneration once the field is put to fallow. This practice retains some soil cover, creates microclimatic differences within the field and speeds up fallow regeneration.	Very widespread
Intercropping	Multiple crops are grown together on the same field, such as millet/sorghum/cowpeas or groundnuts/sesame. This practice reduces soil nutrient depletion when leguminous crops such as cowpeas or groundnuts are included and improves the soil cover, thereby reducing susceptibility to erosion. It also reduces the risk of total crop failure as some crops require more rainfall then others.	Widespread
Crop and landrace selection	Depending on soil properties, the age of a field, and expected rainfall, crops and landraces (often erroneously referred to as varieties) are selected that require more or less soil fertility and/or soil moisture and have a shorter or longer growing cycle. This practice reduces soil nutrient depletion as crops are matched to the available soil fertility and soil moisture and it reduces the risk of crop failure.	Widespread

Continued on next page

Table 6.3 – *Continued*

Practice	Soil and water management	Extent
	Agronomic/biological practices	
Adapted plant spacing	Depending on the crop/soil combination, the "age" of a field and it's topographical position, plants are spaced closer or farther apart. This practice adjusts nutrient and moisture requirements of the crop to the condition of the field and reduces the risk of crop failure.	Common
Thinning	Usually multiple seeds are sown per planting hole and if too many seeds germinate some plants are removed at an early stage or transplanted to empty spots. This practice ensures a spatially balanced "consumption" of soil nutrients and soil moisture by the crop, thereby increasing yield without localized overexploitation.	Common
Mulching	After harvest, stalks are left on the field or grasses and branches are put on the field (during clearing or land preparation) to increase humidity, reduce evaporation, increase soil organic matter, and reduce erosion by protecting the soil surface. Often applied on poorly performing spots to increase yields and maintain soil fertility.	Common
Stubble grazing	During the dry season, livestock is allowed to graze the stubble and stalks that remain once a field is harvested. This practice improves the soil fertility through livestock dung.	Common
Weeding mounds	During the last weeding operation soil is gathered around the feet of the plants to retain humidity when rainfall ceases. This practice increases the yield through moisture conservation.	Less common
Paddocking	After harvest, livestock and especially cattle is kept on a field for several nights in a row so that their dung will fertilize the field. This may be livestock owned by the farmer or by a Fulbe herder. In the latter case food and water are exchanged for paddocking.	Less common
Household refuse application	Year round household refuse is applied to compound fields and some village fields. This practice increases soil organic matter and improves topsoil humidity.	Mainly compound & village fields
Manure application	At the onset of the rainy season, manure of livestock that is kept at the compound (night pen or attached to a pole) is distributed on compound fields and some village fields. This practice increases soil organic matter and improves topsoil humidity.	Mainly compound & village fields
Crop processing residue application	Year round, but especially at the onset of the rainy season, crop processing residue is applied to compound fields and some village fields. This practice increases soil organic matter and improves topsoil humidity.	Mainly compound & village fields
	Mechanical practices	
Perennial grass strips	Perennial grasses and sometimes other vegetation is kept in one or more strips on a field to prevent erosion where runoff is a problem. Sometimes grass is transplanted for this purpose. This practice reduces runoff and erosion.	Less common

Continued on next page

Table 6.3 – *Continued*

Practice	Soil and water management	Extent
	Mechanical practices	
Stone lines	A short row of stones (ranging from a few meters up to a few tens of meters) is placed where runoff water concentrates and tends to form rills. This practice reduces runoff and erosion and retains organic matter on the field. As most of the area is relatively flat, rill and gully formation are not a widespread problem.	Less common
Wood barriers	Branches are placed where runoff water concentrates and tends to form rills. This is done where stones are scarce or when quick action is required. This practice reduces runoff and erosion and retains organic matter on the field, while increasing soil moisture in vicinity of the barrier. As most of the area is relatively flat, rill and gully formation are not a widespread problem.	Less common
Earth barrier	Low earth barriers around a field. Used mainly on compound fields to prevent runoff, manage drainage and retain organic matter on the field.	Mainly compound & village fields
Brick barriers	Clay bricks are sometimes used instead of stones, especially inside the village. See further under stone lines.	Rare
Stalk barriers	Cereal stalks are placed (often with wood pegs to keep them in place) where runoff water concentrates and tends to form rills. This is done when quick action is required or little time is available. This practice reduces runoff and erosion and retains organic matter on the field while increasing soil moisture in vicinity of the barrier. As most of the area is relatively flat, rill and gully formation are not a widespread problem.	Rare
Stone bunds	Unlike stone lines this involves multiple stones piled on top of each other to create a stronger, higher, and usually longer barrier. This is mostly found on steeper slopes and on compound or village fields. This practice reduces erosion, retains organic matter and improves soil moisture availability.	Rare
Earth bund	Large and broad earth bunds used to retain water on bottomland fields for rice cultivation. Prevents excessive runoff (including seed loss), manages drainage, and retains organic matter on the field.	Common on rice fields
Living hedge	Shrubs kept in situ or planted to form a hedge on a field border to reduce runoff and prevent water and wind erosion.	Very rare

Source: Fieldwork.

Table 6.3 indicates for each of the practices how widespread its occurrence is based on observations and information collected in the main and secondary research villages as well as information collected during exploratory visits to 26 villages in the region (chapter 3). Given the emphasis farmers put on organic matter as a source of soil fertility it is not surprising that agronomic/biological soil and water conservation practices are in wide use, though aspects such as the availability of organic material compared to stones or labor requirements also play a role (Mazzucato and Niemeijer 2000). Agronomic/biological practices range from paddocking of livestock, to the application of organic matter and mulches, to the rotation of crops and the practice of fallow. Mechanical practices are less common in the eastern region. A number of practices listed in table 6.3 are discussed in more detail below.

6.3.1 Crop sequencing, crop rotation, intercropping, and fallowing

Crop sequencing, crop rotation, intercropping, and fallowing are important forms of soil fertility management. Crop sequencing involves cultivating different crops as a plot gets "older". Crop rotation is the alternation of different crops on the same plot in a temporal rotation. Intercropping involves the sowing or planting of different plant species on the same plot. Fallowing consists of leaving a plot uncultivated for one or more years. In intensive farming systems fallowing, because it will be only of short duration, is typically part of the crop rotation: a year with millet is for instance alternated with a year of groundnuts with a year of fallow before millet is grown again. In more extensive farming systems, such as that of the Gourmantché, in which fallows typically have a duration of five years or more, fallows are part of the crop sequence rather than the rotation in that after a long period of fallow the crop sequence is started over again. All four practices are very important because time and space constraints limit the widespread application of organic matter inputs.

Crop sequencing

It was already noted in section 5.6.2 that according to informants a freshly cleared field will produce poorly and heterogeneously during the first one or two years, because soil structure and consistence is not conducive to crop growth and because organic matter is not yet sufficiently mixed with the topsoil. It is said that the soil is compact because the soil has been trampled by livestock and because the grasses grow tightly together. Such a compact soil is not very suitable to most crops, and rainwater does not infiltrate very well, especially as the soil is said to seal on wetting. This observation may well point to the processes of sealing and hardsetting described by Hoogmoed (1999). According to informants these effects are less pronounced in case the soil is plowed using animal traction.

Because a new field does not produce homogeneously, it is said that a field should ideally be inaugurated with groundnuts, because this is a less important crop (a low yield will not matter that much because it is not fundamental for consumption) and because its cultivation will soften the soil, preparing it for other crops.[118] In practice, it is explained, a farmer will want to grow sorghum or millet on a new field because one needs to eat. In that case, the initially low yield should be compensated for by cultivating a large area. Cultivating a relatively large area the first year has the additional benefit of, based on crop performance, allowing the farmer to discover the good and bad parts of the new field. In subsequent years the field may be expanded where the soil is good and shrunk where the soil is bad. As clearing a new field takes a lot of time, work parties will often be organized for this purpose (chapter 8).

[118] The practice of first growing groundnuts according to Swanson (1979b) actually takes place the southeastern part of the eastern region.

The crop sequence usually starts with one or more years of sorghum because farmers consider this a fertility demanding crop and want to exploit the natural fertility of the newly cleared field (see also Swanson 1979b).[119] As fertility begins to decline after the third or fourth year, sorghum is replaced by millet. When the soil is still relatively fertile a millet-sorghum rotation may be practiced. This is then followed by a millet-groundnut rotation when the soil has lost most of its fertility. On sandy soils (most notably *tanbipiema*) sorghum is said not to grow well for more than one or two years, even on a newly cleared field. One possibility therefore is to grow a mixture of sorghum and millet the first year and to grow sorghum for a second year only in those places where it did well during the first year.

Crop rotation and intercropping

Crop rotations allow a more gradual crop sequencing by creating intermediate states. Rather than following a few years of sorghum with a few years of millet, a more gradual transition is possible in which sorghum is replaced by a sorghum-millet rotation, followed by a sorghum-millet-groundnut rotation followed by a millet-groundnut rotation. This is an idealized pattern, because in practice different parts of a field are exploited through different rotations and the division of a field in plots may vary from year to year. This depends on the condition of the soil of different parts of the field, but is also determined in relation to the whole constellation of fields and plots that are cultivated during a certain year, and the requirement to produce certain amounts of each crop. For instance, a married man with the responsibility to feed his family, will grow much more cereals than groundnuts and needs to take this into account when he decides what plots to allocate for what crops on his fields in any specific year (this is related to the issue of life cycles that is discussed in chapter 7). This yearly reallocation of plots and crops allows for a much better adjustment of crop production to the condition of the soil than fixed plots and fixed rotations would allow for.

Leguminous, nitrogen fixing crops, such as groundnuts, cowpeas, Bambara groundnuts, and soya are important both in rotations and as intercrops. They allow to extend the period of cultivation, while preventing complete exhaustion of the soil. Most farmers, however, explain the utility of intercropping mostly in terms of the additional production it generates on the same piece of land. This observation is supported with evidence from farmers elsewhere in Burkina Faso as well as field trials (Vierich and Stoop 1990), which suggests that this is one of the ways farmers can increase performance at the costs of little extra labor and without mining the soil. Sorghum and millet are usually intercropped with cowpeas and in Samboanli also with sesame. Groundnuts are regularly intercropped with sesame (especially in Samboanli). Also cereals are often intercropped in the form of sorghum-millet or sorghum-maize mixtures. Farmers explain that this reduces the risk of total production failure and allows to determine which crop best matches the soil (see also Richards 1985; Wolffenbuttel 1997). At the same time it offers another way to

[119] Few soils are considered fertile enough, even upon clearing, to grow maize without organic matter inputs.

adjust the crop to available soil nutrients in a more gradual way than switching directly from a more demanding monocrop to a less demanding monocrop.

Fallowing and selective clearing

As was explained in chapter 4, three different field types may be recognized each with a different level of management intensity: the compound, village, and bush fields (see also Prudencio 1993). Fallow is especially important for the latter category, the bush fields. On these fields the bulk of the cereals is produced and they are too large to allow for the high levels of organic matter input applied to compound fields. Bush fields are therefore cultivated in a bush-fallow rotation whereby a few years of cultivation (using the earlier mentioned crop sequencing and crop rotation practices) are alternated with a longer period of fallow. According to farmers this period of fallow is required to restore soil fertility. The required duration depends on the soil, the number of years it has been cultivated, and the speed of vegetation recovery. As was noted earlier, the latter factor is considered to depend on livestock trampling, but also on rainfall. Yempani Guida explains through what processes fallowing leads to soil fertility regeneration:[121]

> Leaving a field fallow permits the land to recover. During this period of rest, organic debris will build up on the soil and will decompose to become soil organic matter. At the same time the soil remains moist for a long period which permits the trees to develop well. When that has happened you may cultivate it again.

Not only farmers consider fallow as an important means of soil fertility regeneration. Prudencio (1993), for example, citing several sources, suggests that in the West African semi-arid zone, seven years of fallow is sufficient to regenerate soil fertility after three years of cultivation, while Gray (1999) observed, on the basis of soil sample analysis, that in western Burkina Faso soil fertility was already improving after an average fallow period of five years.

Farmers enhance regeneration of the natural vegetation by not completely destroying shrubs and trees during land clearing, allowing regrowth from their stumps (plate VIII). While these shoots will be cut on a yearly basis during the period of cultivation (and branches are deposited or burned on the field), they will allow a speedy recovery once the field is left fallow. Certain trees and bushes are not cut down at all during clearing, because they supply valuable fruits, or have important medical properties (plate IX). Rarely cut down are *Parkia Biglobosa*, *Butyrospermum parkii*, and *Adansonia digitata*. Other trees that are appreciated for their fruits are *Balanites aegyptiaca*, *Zyzipus mauretania*, *Lannea microcarpa*, *Tamarindus indica*. Of these trees *Tamarindus indica* is however considered bad for the soil whereas *Lannea microcarpa*, *Butyrospermum parkii*, *Parkia Biglobosa* are considered good for the soil. Farmers consider woody species important for the maintenance of soil fertility, whether on fields or fallow areas. This importance is confirmed by research. Breman and Kessler (1997) argue, based on a synthesis study of

[121] Interview on 5 February 1998, Samboanli.

over 500 publications, that in a mixed vegetation, woody species increase water and nutrient availability in the Sudan zone, and to a lesser degree also in the Sahel zone.

6.3.2 Crop and landrace selection

Aside from crop sequencing, crop rotation, and intercropping that were discussed in the previous section, crop and landrace selection is an important tool for farmers to match crops and soils in such a way that good yields are achieved while soil fertility is maintained.

Soil-crop associations

Even though, as was mentioned in section 6.2.4, Gourmantché farmers do not consider soil properties and qualities as fixed, they are able to indicate the most common soil-crop associations. Table 6.4 shows the suitability of some of the major local soil types for various crops. Generally speaking, sandy, drier, less fertile soils are considered appropriate for millet and groundnuts while richer, more moist, loamy soils are considered particularly appropriate for sorghum and maize (a pattern also found elsewhere in Burkina Faso, Vierich and Stoop 1990). It may be noticed that the differentiation between black, white, and red sand (*tanbiboama*, *tanbipiema*, and *tanbimoana*) that was reported in section 6.2.1 to be important in terms of soil fertility is also reflected in the suitability for the different crops as assessed by the farmers. This once more illustrates how important such a nuance, which was not recognized by earlier studies of the Gourmantché soil nomenclature (e.g., Swanson 1979b; Müller-Haude 1995; Thiombiano 1995), can be for understanding the link between a local soil nomenclature and land use. Farmers try to exploit differences between soils by planting and sometimes intercropping different crops and landraces.

In practice in about 75% of the cases where soil samples were taken on cultivated plots, the crops planted corresponded with the soil-crop associations given in table 6.4. This implies that in one-fourth of the cases the farmer had not followed the general rules. This discrepancy may be partly explained by technical measures that were taken on some plots to improve the soil characteristics (e.g., organic matter application on the sandy *tanbiboama* soil may allow for maize cultivation). Very important in planting decisions, however, are also socio-economic and cultural considerations. Such as the earlier mentioned need for men to produce enough cereals to feed the family, or the fact that women, to meet their cash needs, will want to have both cereal and groundnut plots (see chapters 7 and 8).

Table 6.4 also draws attention to the conditional nature of some of the soil-crop associations. *Tancagu* is considered to be initially high in fertility and therefore suitable for sorghum in the first years after clearing. An old *tancagu* field is however not considered very suitable for sorghum. To give another example, *ñinmuali* used to be exclusively used for sorghum as it withstands the water-logging, associated with this soil where water emerges from the surface after rainfall, much better than, for instance, millet. Nowadays, lower rainfall levels have led farmers to consider this soil also suitable for millet. While some general rules in terms of typical soil-crop associations can be drawn, these associations are as dynamic as the evaluation of soil properties and qualities (section 6.2.4). It is these kinds of dynamics that limit the utility of collecting local taxonomies. Fifty years

Table 6.4 Suitability of common local soil types for the major crops

Soil[a]	Suitable crops	Unsuitable crops
Baagu	rice, sorghum, maize, sweet potato	millet, groundnuts
Fuanu	sorghum	maize, groundnuts, millet
Gbangbanli	where water infiltrates: maize, groundnuts, sorghum, millet	
Ñinmuali	sorghum (nowadays also: millet)	groundnuts, maize
Tanbiboama	sorghum, millet, groundnuts	maize
Tanbipiema	millet, groundnuts, (sorghum in some cases)	maize
Tanbimoana	groundnuts	sorghum, millet, maize
Tancagu	groundnuts, millet (new field: sorghum)	sorghum, maize
Tinboanli	sorghum, maize, millet	groundnuts
Tinjuabili	sorghum, millet, red sorghum (groundnuts with the right rainfall)	groundnuts
Tinmoanli	sorghum, millet	

Source: Group interviews.

[a]Soil name as used in Pentouangou.

ago, when rainfall was more abundant (chapter 5), a table of soil-crop associations would have looked very different. Informants state that bottomland soils were considered uncultivable due to prolonged periods of flooding. Rice cultivation was done only at a small scale, probably because, with the absence of an urban market for rice at the time, there was little incentive for innovations (such as the currently used earth bunds) that would have allowed greater portions of the bottomlands to be exploited for rice cultivation. *Ñinmuali* was also considered uncultivable because of waterlogging, whereas nowadays the additional moisture provided by sub-surface flow is appreciated by farmers. Instead, the higher, well drained, sandy soils and the sloping *gbangbanli* were considered the most suitable soils for crop cultivation. Based on the discussion of the soil theories of the Gourmantché in section 6.2 it is easy to place these changes in the soil-crop associations in the context of the importance awarded to environmental factors when naming a soil, and to the soil hydrology, when evaluating a soil. This underlines once more the importance of going beyond taxonomies towards an understanding of farmers' theories of soils.

Landrace selection

Landraces (often erroneously called varieties) provide a further means by which farmers can adapt the crops they grow to the possibilities and limitations of the soil. For most crops, farmers are familiar with a rich repertoire of landraces. This allows them to select the most appropriate landrace for the soil (and rainfall) conditions of their plot, thereby making more effective use of available soil moisture while reducing nutrient depletion. Table 6.5 lists the number of known and grown landraces for five of the most important crops grown in the research villages. Especially for sorghum many landraces are known in both villages. This is in agreement with Swanson (1979b: 36), who notes that sorghum is the crop with the greatest number of local landraces (he recorded over 56 distinct landraces). With the exception of rice, more landraces of each of the listed crops are known in Samboanli than in Pentouangou. However, not all known landraces are still cultivated today. Data from a

Table 6.5 Known and grown landraces for selected crops in Samboanli and Pentouangou (Gourmantché only)

Crop	Samboanli Known landraces	Samboanli Grown landraces	Samboanli Dominance of one landrace	Pentouangou Known landraces	Pentouangou Grown landraces	Pentouangou Dominance of one landrace
Groundnuts	3	3	90%	2	2	60%
Maize	5	5	48%	4	3	93%
Rice	6	1	100%	8	4	69%
Millet	7	4	40%	4	2	93%
White sorghum	20	9	51%	15	3	93%

Source: Village census.

village census (section 3.4.2), in which household heads and their first wife were asked for the crops and landraces they cultivated, provide some insight into the number of landraces actually grown in the research villages today. The "grown landraces" column in table 6.5 is based on this survey and shows that the number of currently grown landraces is usually less to considerably less than the number of known landraces. A final column for each of the villages indicates the extent to which a single landrace dominates in the responses obtained from the survey. From the table it may be concluded that in Samboanli more landraces are known, more landraces are cultivated, and few landraces are dominant. Several explanations may be postulated. Firstly, the Samboanli village territory, though smaller, shows greater environmental diversity with probably a greater variety of micro-niches in which certain landraces fare better than others. Secondly, crop cultivation has been important there for a longer period than in Pentouangou, where in the early part of the twentieth century hunting and gathering still formed an important source of livelihood according to informants (chapter 4). Thirdly, Samboanli is located on the borderland of the Sahelian and Sudanian ecological zones, which implies it has access to and requires a wider range of landraces. Fourthly, the declining amount of available land in the densely populated Samboanli (chapter 5) has forced villagers to intensify crop production. Finally, there are a number of socio-economic reasons that are presented in chapters 7 and 8. The relative importance of these factors is however difficult to estimate and requires further research.

Landraces not only play a role in matching crop and soil, and in reducing the risk of total crop failure, but have also been vital in adjusting to the decline in rainfall that has occurred since the wet 1950s in Burkina Faso (chapter 5). Many of the slower maturing landraces no longer reach maturity in time and have been replaced with shorter growth cycle landraces throughout the eastern region (Swanson 1979b), as well as in other parts of Burkina Faso (Vierich and Stoop 1990). Swanson (1979b) notes that the landraces used in any single rainfall zone typically cover a variation in growing season length of around a month. As a consequence farmers in the southern part of the region are now using the landraces that used to be grown in the north, while few people have kept their original, slow growing, landraces, when the dry period appeared to become an almost permanent condition. In extremely wet years, such as 1994, this poses problems as farmers no longer have access to the slow maturing landraces they used to grow.

There are, however, also cases in which a faster maturing landrace is replaced by a slower maturing landrace to better adjust the timing of the harvest of the different crops. An informant in Samboanli explained that the fast maturing three months millet landrace *diye boani* has been replaced by certain farmers since the mid 1960s by the six months *abidjan* landrace because it allows them to harvest the millet after the sorghum. Due to labor availability bottlenecks it is impossible to harvest both crops at the same time, meaning that a short season millet landrace would force farmers to either harvest millet first, which leaves the more vulnerable sorghum on the field, or to harvest sorghum first, which leaves the early ripe millet vulnerable to livestock. A consideration that also comes into play in the choice of landraces is that fast maturing landraces only lead to success if enough people in the area are cultivating them, otherwise birds rapidly consume the production of the few early ripe fields. These examples illustrate that there is often a complex reality beneath a generic, simple story, such as that the decreasing rainfall levels have led to the use of faster maturing landraces.

6.3.3 Organic matter utilization

Livestock paddocking and manure application

Paddocking of small ruminants is common in both villages. Small ruminants are either kept in a pen, inside or near the compound, or on one of the compound fields (usually intended for maize cultivation). In case they are kept inside the compound, manure will generally be transported to the maize field of the compound or household head at some point during the dry season. There it will remain in piles, together with household refuse, until it is spread out over the field as the rains approach (plate XII). According to farmers, the small piles have two benefits: the wind is less likely to carry the material away and the material decomposes better. Where the small ruminants are kept near the compound, manure may either be transported to the maize plot or, as often happens in bush camps, the maize plot will be shifted to the location of the pen and the ruminants will move to another place. In some cases sorghum will be cultivated at the previous location of the maize plot. In cases where small ruminants of several family members are kept together it is the compound head or household head that will be entitled to the manure. Women therefore have less access to manure. Donkeys are also kept near the compound thus enriching the compound fields. Horses are rare nowadays and none were encountered in the research villages.

Cattle ownership is becoming increasingly popular among the Gourmantché (chapter 4). Cattle are often guarded and herded by the Fulbe (chapter 8). Thus not everyone who has cattle actually has access to their manure. In both villages some Gourmantché households keep at least one cow or bull inside, or in front of, the compound during most of the year, mostly for livestock fattening purposes. Especially in Samboanli this is becoming more and more common according to both Gourmantché and Fulbe informants. The animals are paddocked on maize fields, or manure is transported to those fields.

It also occurs that Gourmantché farmers invite Fulbe from nearby villages, or those passing by on transhumance, to stay for several days, up to more than a month, on their fields during the dry season.[121] This form of cattle paddocking is more frequent in Samboanli than in Pentouangou. Its occurrence and frequency changed over time as a result of the dynamics of the institutional arrangements between Gourmantché and Fulbe that will be discussed in chapter 8. An important factor involved is also the availability of water during the dry-season. Especially in Pentouangou there are many farming areas where water availability is a key constraint to this practice.

Other organic material application and mulching

Apart from manure, various other kinds of organic material are applied to, especially, the compound fields. This includes household refuse, crop processing residue (such as bran), ashes and old roofing and mats. Immediately in front of the compound the resulting layer can be up to several centimeters thick near the mortars. Again, it is primarily the maize fields of the compound and household heads that benefit, though women may ask their husband to allow them to use this organic material on their fields in case the productive capacity of these fields begins to fail. At this point the husband may also decide to look for a new field for his wife. Also in bush camps organic matter is applied in the vicinity of the huts. The amount of available organic matter is however much less as the family stays there only during the rainy season and usually with fewer people than in the village compound. Because less organic matter and manure is available in the bush compound, not all men have a maize field there. Even when a household head is staying in a bush compound during the rainy season, he will often have a maize field at home in the village.

Mulching is one of the most common agronomic/biological soil and water conservation practices that is applied by both men and women. Various kinds of mulches are used. Frequently the mulch consists of leaving stalks on the field after the harvest or repositioning them on the poor denuded parts of a field. Branches from shrubs are also used as a kind of mulch/organic matter application. Sometimes this concerns branches of shrubs that were cut down during clearing, in other cases branches are cut from trees or shrubs outside the field and then applied on denuded spots of the field. In more recent years some farmers have begun to cut and collect grasses and use them as a mulch on the field. This they explain to have observed with the Mossi, where mulching with grasses is more widespread (see Slingerland and Masdewel 1996). Farmers say that in those places where the soil, for lack of SOM, tends to become bare they apply a mulch. They explain that a mulch applied early in the season will have been partly consumed by termites before the rains set in (plate VII). After two or three showers the mulch will further decompose and keep the earth moist while increasing the amount of SOM. Farmers mention this increased humidity and fertility as the main reason for applying mulches and other forms of organic matter. It is interesting to note that farmers apply mulches primarily in places where crop production is lagging behind, rather than investing all efforts and inputs on the best parts of the field. This is also noted by Lamers *et al.* (1998), who investigated the effectiveness of

[121] Brouwer and Powell (1998: 353) note that even a single night of cattle paddocking per year on a single spot can be enough to attain maximum yield on that spot.

this practice in an experimental study and concluded that it is rational from both an agronomic and economic point of view.

As far as mulching with crop residue is concerned there is one important adversary: livestock. As livestock numbers are growing (chapter 4), crop residue becomes increasingly sought after. Groundnut and cowpea stover is used to feed small stock during the dry season. Millet and sorghum stalks are used for cattle and donkeys. This implies that in those cases that farmers keep their livestock at home they will collect the best stover after the harvest to store as dry season fodder for their animals. Stalks are also used for constructing fences around cassava fields or between the huts of a compound.

Farmers do not consider burning of bushes or crop residue good practice, because it enhances the fertility of the soil only on the short term and a lot of organic matter is considered to be lost in the fire. Because of the burning, the soil is said to die and there will be no organic matter for decomposition during the next season. Continued burning will result in bare land on which not even grasses will grow (*penpeligu*). Still, there are many instances where farmers do burn, such as after clearing of a new field and when there are too many thick stalks on the field. If left on the field, such thick stalks pose several problems: the risk of covering young plants when working the field, the risk of cutting oneself if the hoe slips during land preparation, and the risk of hidden snakes. According to some informants, farmers burn less now than in the past, partly because of the campaigns of the agricultural extension service. In the past, it is said by these informants, people would burn their field after the harvest, following the browsing by livestock of the fresh residue.

In general, it can be said that where manure, mulch, and organic matter is applied depends on crop requirements, soil properties, distance of fields from the village, and on issues of access that are dealt with in chapter 8. Demanding crops such as maize and sorghum will more often benefit from these fertility enhancing practices than millet or groundnuts. Some soils are considered more responsive to organic matter application than others. Farmers, for example, explain that for soft sandy soils the application of organic matter is less effective as the soil is unable to hold it long enough for the crops to benefit. In bottomlands or water courses organic matter is not applied, because there is a considerable risk that at some point the water will wash away whatever had been applied, while at the same time such soils already receive naturally deposited organic matter input. In those places where organic matter application is deemed essential, but where there is considerable erosion, farmers construct erosion reducing barriers (see section 6.3.4).

Generally speaking there are two kind of places that receive organic matter, manure, or mulches. First of all, there are the long-term cultivated compound fields on which maize and red sorghum are grown. Secondly, there are the poor denuded sites on other fields where crop production lags behind. In the latter case farmers use inputs to improve the poor parts and thus get a more homogeneous production level (plate XI). In both cases the area to which inputs are applied remains relatively small. The compound fields are generally small as are the denuded spots on other fields. Time and transport constraints play a major role in limiting organic matter application to relatively small areas. The highest level of inputs are generally found close to the compound where transport is not such an issue and plots are small.

Weeding practices

Also weeding practices can contribute to soil and water conservation. During the first and second weeding (often combined on large fields due to labor constraints) weeds are usually not removed from the field, but deposited in small piles on the field. Farmers explain that these piles will decompose and supply SOM to the plants (plate XI). In some cases it was observed that farmers deposit the weeds along the edges of maize fields thereby creating a small erosion reducing barrier. During the third and last weeding the soil and weeds are really turned over and piled up in ridges around the stems of the plants. It is explained that this improves the fertility, but above all increases the humidity around the plants during the final part of the rainy season when rainstorms are becoming rare. The ridges also reduce runoff and increase infiltration. Finally, they strengthen the plants against the fierce winds that accompany the last rainstorms of the season. Swanson (1979b: 47-49) also mentions this practice and notes that it is a traditional activity of good farmers and that some farmers (due to unforeseen labor shortages or laziness) never get to this last weeding. Informants claim that much more time is dedicated to weeding nowadays than in the past.

6.3.4 Mechanical measures

As was shown in section 6.2.2 farmers are well aware of the erosive force of runoff. They not only recognize gully and rill erosion but are also aware of the slower, less conspicuous effects of sheet erosion. There is general agreement among farmers that certain types of fields require mechanical protection measures to prevent erosion for the simple reason that production would otherwise decline too rapidly. This depends primarily on the topographical position of the field in the landscape. Fields that are on elevations (*gbangbanli*) or at top of a slope are said to require protective bunds, while this is said to make little sense for fields at the bottom of a slope, on flat land, in a depression, or on the bottomlands (with the exception of the earth bunds for rice cultivation, but those are not constructed to prevent erosion, but to retain water).

Most erosion reducing barriers encountered on farm fields are small barriers (with lengths of a few meters to a few tens of meters) that are constructed across the passage ways of runoff. Such barriers are called *kuali* which is also the word used for earth barriers. Stone lines are called *tankuali*, wood barriers *dakuali* and grass strips are called *mokuali*. The kind of barrier is primarily determined by the force of runoff, the available materials, the access to means of transport and the available time and labor for construction.

Earth barriers are most common on compound fields. Compound fields are generally small and as a consequence the force of runoff is limited because of the short slope length. Wood and stones are not always readily available and an earth barrier of some 10 to 15 cm high is relatively easy to construct. Much higher and broader earth bunds are found on the bottomlands, for rice cultivation. These can be as much as a meter high and broad and are generally made with soil clods enforced by upright branches. In the bottomlands earth is the preferred material because it is the least permeable material, allowing it to retain water on a rice field. Bunds are regularly heightened and repaired in response to strong damaging currents. These bunds may be as much as 100 to 150 meters in length. The use of such earth bunds for rice fields is a relatively new phenomenon in Pentouangou, where it was introduced together with rice cultivation by migrants from the north who had probably picked it up through the agricultural extension service. In Samboanli almost no rice cultivation currently takes place.

Stone lines (10-15 cm high) are said to be the preferred type of barrier on the higher lands because of their strength and the fact that neither termites nor wood gathering women take them away. Their construction does however require the vicinity of stones or appropriate means of transport such as a donkey cart. This is frequently a problem, in which case wood barriers will generally be constructed in place. Because stone rows require collection and transport of stones their construction is also far more time consuming than most of the other soil conserving practices. Some farmers occasionally use mud-bricks instead of stones, when the field is close to the compound (see also Wolffenbuttel (1997) on the variety of materials farmers may employ to construct a barrier). Stone bunds, which are higher, broader versions of the stone lines and typically introduced by development projects and the extension service, are not very frequent in the research villages, where no such projects have taken place. In Samboanli some farmers have constructed such stone bunds on their compound or village fields.

Wood barriers (10-20 cm high) are not as durable as stone bunds (with the exception of complete tree trunks), nevertheless they are perhaps the most common type of barrier encountered on bush fields. Small trees and shrubs are relatively abundant and need to be cut down for field clearing anyway. Where runoff does not have too much force and stones are not readily available, wood barriers are considered a good alternative (plate X). An additional benefit is that it is much easier to quickly cut down a number of branches to place a barrier in a part of the field that does not perform well, than to collect stones in the midst of the agricultural season. Wood barriers are usually fixed in place with wooden pegs that are stuck into the soil. Wood barriers will often have to be replaced, or at least be repaired, at the beginning of the next season. Where firewood is getting scarce in the vicinity of the village, such as in Samboanli, men will allow their wives to use the wood for firewood before someone else "steals" the barrier. Termites are another problem.

Especially wood barriers, but also stone lines, are often combined with grass strips. Grass (especially *Andropogon gayanus*) is either kept in situ or transplanted next to the barrier at the beginning of the rainy season to enforce it. Grass strips are also found separately, transplanted, or kept in situ during land clearing.

Barriers made from sorghum or millet stalks, as one sometimes encounters in, for instance, the Yatenga have not been observed, but were reported in Samboanli in the technology survey (see section 6.3.5).

According to farmers, the main purpose of all these barriers is to keep organic debris and SOM on the field. Water conservation is not mentioned as a reason to construct these barriers and the barriers are therefore small in length and generally limited to the passage ways of runoff (Mazzucato and Niemeijer 1998). Barriers may occur at the downslope limit of a field, but more often they occur inside the fields, sometimes at several positions along the slope. Apparently, there is no great concern with the reduction of the cultivable area by the barriers, as is sometimes mentioned in the literature as a reason for the non-adoption of mechanical soil and water conservation technologies. The barriers are constructed more or less perpendicular to the slope, following the micro-relief. As there are no soil and water conservation projects active in the research villages, no use is made of a water-level (or A-frame) to follow the contours.

Barriers are seldom laid down in one go, but are gradually extended year by year, growing both in numbers and size. This allows farmers to make adjustments based on observed erosion and crop production. It also allows them to spread the labor over multiple years. Work parties for the construction of barriers have not been observed in the research villages, but the size of the barriers most farmers use are probably too small to call a labor party for their construction (see Mazzucato and Niemeijer (2000) for some other reasons).

6.3.5 Changing use of soil and water conservation practices

In the introduction to this chapter it was put forward that certain researchers have observed a decline in the use of "traditional" soil and water conservation practices. Reij (1983) for instance suggests that the uses of stone lines in Burkina Faso was abandoned at the beginning of the twentieth century probably as a result of the colonial practices of forced labor and taxation, which may have led to a disintegration of the agricultural system.

Also in the eastern region there are indications that the use of stone lines was more frequent in the past. In the area around the secondary research village in the north (see chapters 3 and 4 in relation to the secondary research villages) many remains of stone lines were for instance encountered on long-time uncultivated bush land. Also in Samboanli such remains were found, but less frequently. In Pentouangou, were hardly any stone lines may currently be observed on bush fields, quite a number of remains of stone lines were encountered in the bush, far away from today's fields. These remains are said to date back, twenty, forty, sixty, or more years. In some cases it is not even known anymore who constructed the stone lines at those sites. For the other kinds of barriers it is very difficult to get a good grip on the historical dimension of their usage because, being made of organic material or earth, they do not leave behind physical evidence of their use. Even with stone lines this can be a problem. Ten stones that were once used to block a passage-way of runoff may now lie partly scattered near this site and will thus easily be overlooked. Also in interviews it is hard to get at the details of changes in time, because informants may be referring to different farming areas or to different sizes of barriers. Stories related to the material evidence may also be contradicting. Where one informant would say that this had been constructed at least 50 years ago to prevent erosion another would say that these old stone lines were the remains of old, a few tens of centimeters high fortifications behind which people would hide for the arrows of their adversaries, then quickly rise and shoot, and lie down again. However, taking all the bits and pieces of physical and oral evidence together it is clear that especially in Pentouangou mechanical soil and water conservation practices, particularly of the more durable kind, such as stone lines, are used less now than in the past.

At first sight, this seems like a conformation of the theory that "traditional" practices are being abandoned. However, when informants were asked why mechanical practices are used less now than in the past, a very different story emerged. Especially in Pentouangou, where the difference between past and present practices is most pronounced, informants explain that the reduced rainfall levels of recent decades no longer allow sufficient yields on higher situated fields and people therefore no longer cultivate the kind of fields that require erosion reducing barriers. That fields have been moved from higher and sloping land to flat and lower land is also confirmed by farmers in Samboanli and elsewhere in the region (Swanson 1979b). Also for other parts of Burkina Faso it has been observed (Vierich and Stoop (1990) for example note it, but attribute it to declining soil fertility of the uplands). It was also noted earlier, that farmers consider the need for erosion reducing barriers in relation to the topographical position of a field. In other words, there is considerable support for the suggestion of informants that the decline in use of mechanical practices is a result of an adaptation to changing environmental conditions, rather than a sign of a disintegrating farming system. The virtual absence of stone lines on bush fields in Pentouangou would in this context thus not be a sign of either a lack of awareness of soil erosion or a lack of knowledge about erosion reducing technologies, as a casual observer might conclude. More importantly, the fact that stone lines were used in Pentouangou in the past (20 to 60 years ago), when population pressure was even lower than today (around 5 inh. km^{-2}), indicates that erosion prevention may also take place in situations were land is not scarce. This is in contrast to Vierich and Stoop (1990: 121), who, speaking of the Sudanian and Sahelian zones of Burkina Faso, claim that:

> Until a generation ago, the fragile soils of upper slopes and uplands were commonly fallowed 20 years or more after 5 to 6 years of cropping. Because of this practice and relatively small sizes of the bush fields, farmers were not concerned about managing soil fertility through applications of manure and the use of crop rotations, nor with water management to control erosion and runoff.

In Pentouangou investments in soil fertility and erosion control were made, also a generation ago, despite the extensive practice of fallows following short periods of cultivation. Also in Samboanli, which in the mid 1950s had an estimated population density of 15 inh. km^{-2}, such investments were made already at that time. Even earlier, villagers from Pentouangou would invest in erosion control, as is clear from an interview with Toumbengu Thiombiano, born in 1918, on the practices of his forefathers:[123]

> During the time of my grand parents, people would stay for some time at the same field. They did not live from millet and sorghum alone. They had meat and they lived in good health. It was not the crops that formed the basis of their subsistence. From time to time they would however look for a different field when the soil became exhausted. In case runoff did not affect a field, it was not necessary to construct barriers. On the other hand, if runoff would take away the organic matter that is where they would plant a grass strip and place stones. Also wood. If there was a rill or gully and there were no stones nearby, they would cut wood and place it next to the grass strips so that the runoff would not be able to take away organic material. During the rainy season they would uproot grasses, those used to make brooms, and plant them

[123] Interview on 24 February 1997, Pentouangou.

Table 6.6 Changing land use patterns in Pentouangou (1955-1987) and Samboanli (1955-1994)

	Pentouangou			Samboanli		
	Total area (% of territory)	Cultivated area[a] (% of landform)		Total area (% of territory)	Cultivated area[a] (% of landform)	
Landforms		1955	1987		1955	1994
Hills	9.0	0.9	9.9	5.7	16.8	2.6
Steep slopes	0.0	–	–	0.5	0.0	0.0
Gentle-medium slopes	16.9	1.8	3.1	20.7	18.0	20.4
High plateaus	19.3	2.9	3.9	0.0	–	–
Undulating landscapes	11.5	2.0	12.9	4.9	27.0	20.7
Low plateaus	32.2	0.7	9.2	49.2	25.2	64.4
Upper bottomlands	6.0	2.4	1.6	2.5	33.5	73.2
Lower bottomlands	5.0	5.2	26.3	16.6	14.4	91.2
Total	*100.0*	*1.8*	*8.0*	*100.0*	*21.6*	*54.0*

Source: Aerial photo interpretation.

[a]Cultivated area includes recent fallows that cannot be distinguished from cultivated fields on the aerial photographs.

on the field. Subsequently, they would take wood and place it next to the grasses to give them support until it was clear that the grasses would not die.

The observation by informants that hills, elevated areas and slopes have been abandoned in favor of flat and low lying land is supported by a temporal analysis of aerial photographs from the mid 1950s and the late 1980s (Pentouangou) and early 1990s (Samboanli).[124] Table 6.6 shows for the research villages the proportion of the village territory occupied by different landforms and for each of these landforms what proportion was cultivated in respectively 1955 and 1987 for Pentouangou and 1955 and 1994 for Samboanli. In Pentouangou the total proportion of cultivated land (including recent fallows) increased from 2% to 8% between 1955 and 1987. From the table it can be seen that gentle-medium slopes, the high plateaus, and the upper bottomlands hardly contributed to this growth, whereas a large growth was achieved on the hills, the undulating landscape, the low plateaus and the lower bottomlands. With the exception of the hills these are all flatter and/or lower lying areas. The unexpected growth on the hills is actually due to the compound and village fields of the Duolipo ward that was established on a slight hill, and thus has little bearing on the general tendency to cultivate less sloping lower lying land. For Samboanli the pattern is similar in that growth has mainly been achieved on low plateaus, and lower bottomlands, whereas hills have been virtually abandoned. In sum, the analysis of the land use changes based on aerial photographs clearly supports the observation of the informants.

Table 6.6 also provides an explanation of why the difference between past and present use of mechanical soil and water conservation practices is more pronounced in Pentouangou than in Samboanli. In both villages the same shift towards flat and low lying landforms has taken place, but in Samboanli, where land is in much shorter supply, such

[124] Compare also the two enlarged aerial photographs in section 5.3.2.

locations are now almost completely occupied (of the low plateaus and bottomlands 65% to 90% is currently used for arable farming). This leaves farmers in Samboanli much less choice in terms of the landforms they cultivate. Many farmers therefore still cultivate relatively elevated or sloping land. It is thus not surprising that stone lines and even wood barriers are more regularly observed in Samboanli. In several wards, most notably in Kolonkuomi and Kalinkami, long stone bunds have been constructed for the compound and village fields. Also on bush fields stone lines and wood bunds are more common in Samboanli. The availability of stones and the higher population density that has led to longer cultivation periods in the vicinity of the village also explain why more of these mechanical measures may be observed in Samboanli.

As the differences between Samboanli and Pentouangou demonstrate, declining rainfall and geomorphology are not the only factors affecting the usage of soil and water conservation practices. The higher population density in Samboanli has forced farmers to cultivate land, especially land in and near the village, with greater frequency. The fact that this, as was demonstrated in chapter 5, has not lead to soil degradation suggests that soil and water conservation practices play an important role.

To get an indication of the use of soil and water conservation practices in the two research villages a technology survey was conducted. Due to some problems that were discussed in chapter 3, the sample was not completely random and smaller than envisioned. Nevertheless the data may be considered indicative (though not necessarily representative for the whole village population). Based on the data from 19 Gourmantché women in Pentouangou and 28 in Samboanli figure 6.2 was compiled. This figure shows for a number of soil and water conservation practices per field type how many women (who cultivated one or more of such fields) used the practice on one or more of their fields in 1996. Rice fields were excluded from the analysis because these were only found in Pentouangou and always require bunds to retain water on the field.

The graphs in figure 6.2 seem to indicate certain trends. Firstly, in terms of the mechanical practices, grass strips, stalk barriers, wood barriers, and stone lines are more important in Samboanli than in Pentouangou, especially where the bush fields are concerned. In Pentouangou earth barriers are relatively important on the compound and village fields. Secondly, women in Samboanli specifically state that they do not burn the crop residues on some of their fields, while none of the women in Pentouangou answered affirmatively to this question. Thirdly, mulching on compound and village fields, while applied by women in both villages, is primarily applied with crop residue (stover) in Pentouangou and with grasses in Samboanli. This is probably a reflection of the fact that crop residue in Samboanli is also used for cooking during part of the year and is an important source of livestock feed during the dry season. This implies that there are at least two reasons why women in Samboanli generally do not like to burn their crop residue. In the village they use the stover for other purposes and on the bush fields they use it for mulching. Fourthly, compound refuse is equally applied by women from both villages on compound and village fields. Women in Samboanli, however, also apply refuse from the bush compounds on their bush fields. Fifthly, women in both villages use only limited amounts of manure (through paddocking or the application of collected manure). Finally, it may be observed that the major difference between the two villages is that women in

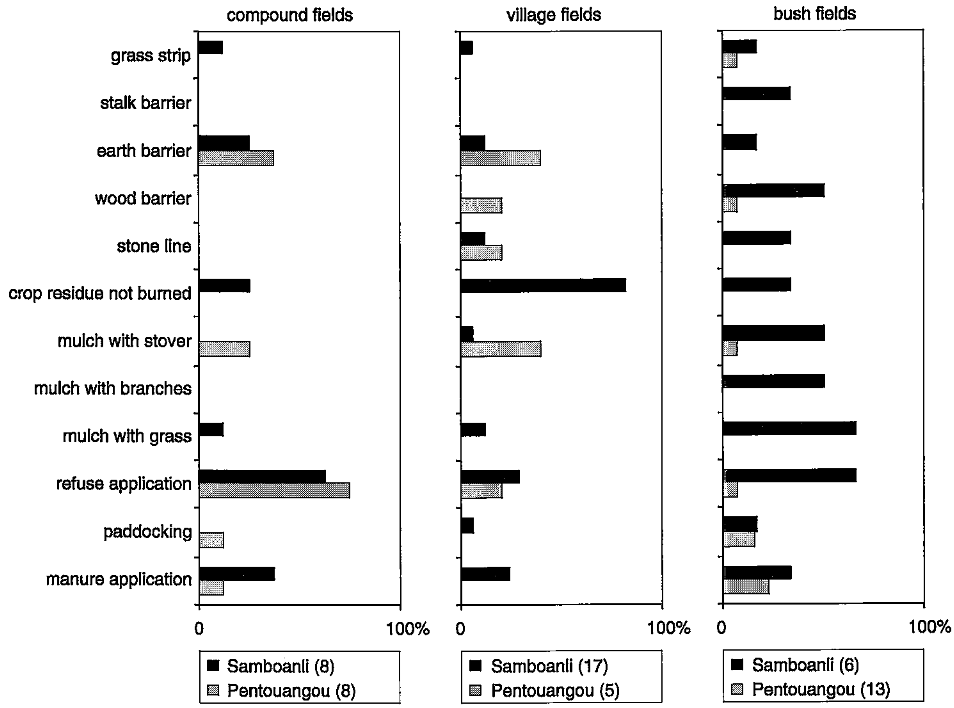

Figure 6.2. Indication of the use of selected soil and water conservation practices used by married women in Samboanli and Pentouangou (number of cases per village between brackets)

Samboanli undertake much more soil and water conservation on their bush fields compared to those from Pentouangou. All of these indications are in line with observations during fieldwork and information obtained from interviews.

Figure 6.3 presents the same information as figure 6.2, but for male respondents. The data are derived from responses by 16 men for Pentouangou and 13 for Samboanli. In this case no real comparison can be made for the village fields, because only 3 respondents are available for Pentouangou. For the compound fields the main difference between the villages is that in Samboanli there are again farmers who explicitly say not to burn crop residue, while in Pentouangou this is not mentioned. As far as the bush fields are concerned practically all practices are found in both villages, but the frequency in Samboanli of both mechanical practices and mulching is higher, as is the application of manure.

Taking both figures together, several further observations can be made. Firstly, women generally have less access to household refuse and manure for their fields than men. Secondly, in both villages agronomic/biological conservation practices are in much wider use than mechanical ones. This can be attributed to various factors. As was already noted, farmers consider mechanical practices only useful on fields in elevated positions and on sloping land, because they are mainly used to prevent excessive erosion. Agronomic/biological practices, on the other hand, are mainly used to counter soil exhaustion by crop growth and therefore considered relevant for all fields. They are considered more important for fields on which demanding crops are grown such as maize and sorghum, but they may be applied on any field in order to lengthen the period of cultivation. Another reason why agronomic/biological practices are more widely used is that they are often less labor intensive. Those that are labor intensive, such as the transport and application of manure and household refuse to further away fields, are also less frequent. Finally, many of the agronomic/biological practices have the benefit of being more flexible. One year they can be applied to one part of the field, another year to another part of the field. In an environment with a large spatial variability of the soils this is an important benefit (Mazzucato and Niemeijer 1998). Also from a social point of view this has its advantages as labor can be allotted on a piecemeal basis (chapter 8) and because they tie in well with the use of social networks to access the necessary resources (Mazzucato and Niemeijer 2000). Barriers, to be effective, require yearly maintenance. Thirdly, grass strips and mulching with grasses is virtually limited to Samboanli, while, in accordance with earlier observations, stone lines are considerably more important there than in Pentouangou. Finally, for both men and women the differences between the villages are most pronounced where the bush fields are concerned. This suggests that, whereas compound and village fields are cultivated with a comparable intensity in both villages, there are signs of increased intensification of bush field cultivation in Samboanli, in terms of soil and water conservation practices. This may be one explanation why the greater cropping frequency required in this village as a result of the higher population density has not led to soil degradation.

In sum, it may at this stage be concluded that the use of soil and water conservation

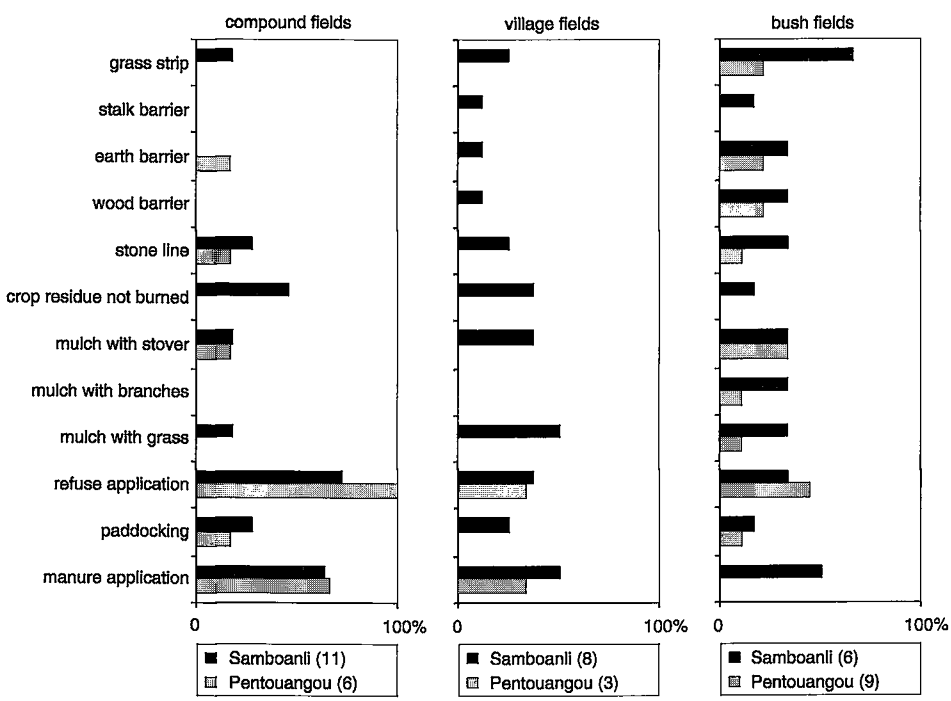

Figure 6.3. Indication of the use of selected soil and water conservation practices used by married men in Samboanli and Pentouangou (number of cases per village between brackets)

practices in the research villages is the outcome of multiple factors, among which are environmental processes such as changing rainfall levels and distribution, environmental conditions such as soils and geomorphology and demographic changes as reflected in augmenting population densities. In other words, there are no signs of a disintegration of local soil and water conservation practices, on the contrary they appear to be alive and dynamic.

6.4 Adaptive management

In the previous sections it was shown that farmers have extensive knowledge of their natural environment and use this knowledge to adapt their land use practices to the possibilities of the environment in general and the soils in particular. It was demonstrated that in this process they make use of soil and water conservation practices to overcome the limitations of certain soils and to allow for multiple years of cultivation without nutrient depletion or excessive erosion. It became clear that this adaptation was not a static one to fixed conditions, but a dynamic adaptation to changing environmental and social circumstance (though the latter aspect will be discussed in more detail in chapters 7 and 8). There is, however, yet another level at which adaptation takes place. That is within the time frame of the cultivation cycle of a single plot, from being cleared for cultivation to being abandoned and reverted to fallow.

Section 6.3.1 already revealed how crop sequences are used to adjust crop production to changing soil fertility levels as a result of crop cultivation, and how newly cleared fields are gradually expanded. These are not exceptions, but are part of a more general cultivation strategy that is based on what will here be called adaptive management. Soil and water conservation is not done beginning day one on a newly cleared field, but takes place in a gradual interplay between farmer and environment. This is best illustrated in the form of an example.

In February 1998, Yabre, a farmer from Samboanli had 18 erosion reducing barriers with a total length of 250 meters on his 1.3 hectare bush field. These barriers had been constructed with various materials: stones, wood, pieces of pottery, and living grasses. Some consisted of a single material, while most consisted of multiple materials. Yabre first started cultivating this field in 1992, after a fallow of more than 20 years. He estimates that about 40% of his field is *fuanu*, which he considers the best soil because, as it is a drainage course, it is humid and has a lot of SOM. Another 30% consists of the gravely *tancadigu*, which he considers the second best soil of this field because it is fertile. The remaining 30% consists of the elevated *gbangbanli* (25%) and the denuded *penpeligu* (5%) which are neither fertile nor humid. Because Yabre considered the field as a whole to be relatively fertile he cultivated sorghum for the first five years (two different landraces intercropped with cowpeas). It was only in the sixth year that he planted millet in some parts of the field because of striga problems in relation to a declining soil fertility. Every year Yabre expands the field a little. (In 1997 he had for instance expanded it 0.02 ha compared with 1996.) A map of the field as it looked in February 1998 is shown in figure 6.4.

During the first year he noticed that the small drainage course (*fuanu*) crossing the slightly sloping field was causing too much erosion and he therefore transplanted grasses to

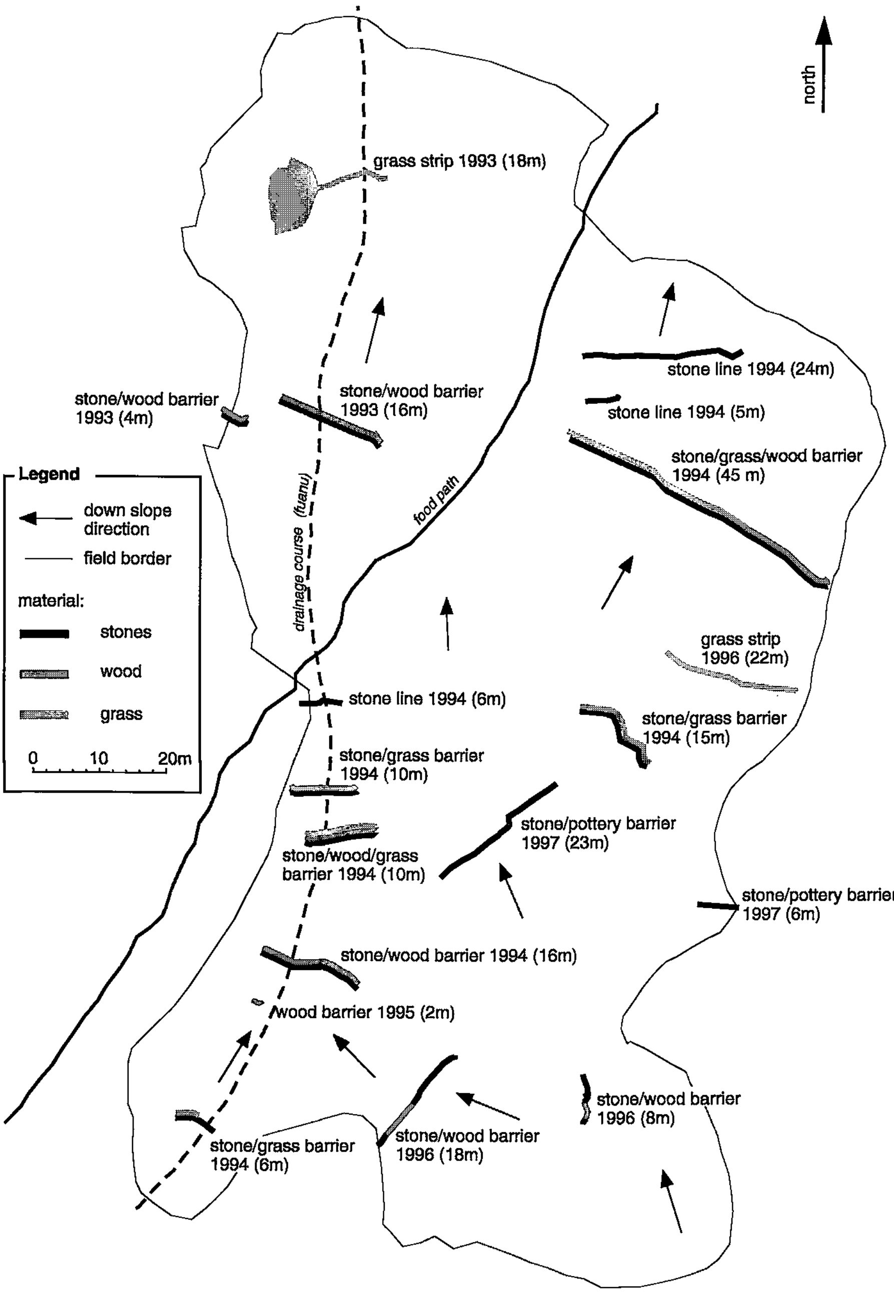

Figure 6.4. Field in Samboanli with mechanical soil and water conservation practices constructed between 1993 and 1997.

Note: February 1998 state mapped with differential GPS. Shapes and locations of bunds are approximate.

form a grass strip and constructed a first stone line enforced with wood in time for the second season (see figure 6.4). For the subsequent season (1994), aside from repairing the existing barriers, several more barriers were laid out across the drainage course as well as on a few other parts of the field. In the years to come, more barriers were added, existing barriers repaired and extended as Yabre noticed that in some parts crop production was decreasing as a result of declining soil fertility. As the wood of the wood barriers was taken away every year by wood gathering women, some were repaired while others were (in part) replaced by stone lines. In 1997 Yabre started applying grasses and crop residues to the field to keep up the production level. He explains that where the sorghum did not produce well the stalks will have a lot of leaves and he thus removes them from the field for animal fodder. Towards the beginning of the next rainy season he spreads out the remaining stalks (the tougher ones) over the field. He explains that doing this immediately following the harvest makes little sense as passing livestock will still consume a part. He did not apply mulch to the water passage-way because he considered that this makes little sense, even with the bunds in place. Yabre expects to continue to cultivate this field for some more years to come, expanding the cultivated area a little more every year.

He has good reason to continue cultivating this field. In both 1996 and 1997 the yield was measured on two 5 x 5 m squares, one located on the worst site and one located on the best site of the field (see section 3.5.3). While the worst site produced as little as 108 kg ha^{-1} in the average rainfall year 1996 and nothing in the low rainfall year 1997, the best site produced as much as 1,700 kg ha^{-1} in 1996 and 2,200 kg ha^{-1} in 1997. The estimated production for the field as a whole, based on a farmer estimate of the production, was almost 1,000 kg ha^{-1} in 1996 (for 1997 no data are available). These yields are not bad for a field on sloping land that has been cultivated for five to six years.

The example clearly highlights how Yabre responded with a variety of soil and water conservation practices to the changing properties of the soil under cultivation. This way he is able to extend the period of cultivation while keeping a balance between labor input and expected crop production. The example further illustrates the emphasis on soil rather than water conservation (he made the bunds in response to fertility decline) and also how the dynamic perception of soil properties influences the agricultural decisions (use of soil and water conservation and crop choice). It is also interesting to note that, while Yabre recognized four different soil types on his field, he did not exploit this difference by growing different crops during the first five years. He preferred to accept that some parts would yield poorly, rather than complicating his work and increasing his labor input by growing different crops on different parts of the field. He shares this preference with most of the other case study farmers. Where differences are clear and concern large, more or less homogeneous areas a farmer will grow different crops on different plots. Where smaller areas are concerned, even when differences may be substantial, he prefers to grow a single crop. There are of course exceptions to this rule as the following example shows.

One of the women in Pentouangou, Kilpoa, started to cultivate a village field near her compound in 1996. Before her, someone else cultivated it and she estimates that it has been continuously cultivated for at least the last 40 years. The previous owner had grown groundnuts on the whole field. Kilpoa, however judged that whereas the field as a whole was very low in fertility there was a small part (maybe some 10 m^2) that had too much organic matter for groundnuts, so she planted okra there instead. She explained that this used to be a hole where people had dug-out clay in the past to build a place for grinding grains in their compound, and that it had been used by the inhabitants of a now no longer existing compound to deposit their household refuse. That is why this soil, called *Tanbuogu,* has a lot of SOM she explained. In effect, soil analyses confirmed that this part of the field had 5% organic matter in the topsoil compared to 0.9% for the remainder of the field. A difference that Kilpoa effectively exploited by growing a more demanding crop.

Adaptive management may also take place within a single growing season. Sowing decisions, for example, are continuously adjusted as work and season progress. This sometimes posed considerable problems for the measurement of field areas, as the field was extended and shrunk until as late as the end of July. Noticing this problem, one of the research assistants was asked to write down, for some of the fields that had to be measured, how the sowing decisions developed in the first months of the rainy season. An example for one of the bush fields of, Piampo, a man from Samboanli is given below.

Piampo had taken this field in production in 1993 after a 13 year fallow. Between 26 May and 1 June 1996 land preparation took place, followed by the application, on some parts of the field, of 15 wheel-barrows full of chaff, originating from where sorghum and millet had been threshed. On 9 June he started tillage with a donkey plow. While tilling the field, parts of the field were sowed, depending on the rainfall, the crop and landraces used and the characteristics of the specific location. All the time it was unclear which parts would be sowed and when. Around 25 July the limits of the individual plots had still not been fixed because Piampo was still undecided on what to sow on certain parts of the field. Eventually, the field attained a total size of 3.6 ha for a total of 6 plots planted with sorghum or millet. Despite Piampo's doubts, or perhaps because of his careful decisions, an average yield obtained on the main millet plot (2 ha) was around 1,100 kg ha^{-1} and for the main sorghum plot (0.8 ha) around 2,400 kg ha^{-1}.

This last example brings out a very important point, which is that not all that happens on a field is based on a pre-determined design. As Richards (1989: 40) argues, on the basis of an example drawn from a study of Hausa farmers in Nigeria by M. Watts, the layout of different crops in a field "is not a design but a result, a completed performance." In other words, it is not the result of some kind of combinatorial logic, but the end result of sequential adjustment to unpredictable conditions (Richards 1989). To return to the example of Yabre's bush field: the adjustments Yabre made to the barriers on his field were not part of some master plan, but the outcome of an interplay between agronomic knowledge, observations of crop performance, experimentation, timing and amount of labor available, availability of material to construct barriers, rainfall dynamics, and other chance events. Had rainfall been different, or had a family member fallen ill at a certain moment, barriers would probably have been located in different places, would have had different lengths and would have been made of different materials.[124]

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[124] It is, for example, unlikely that the use of pieces of pottery for some of the barriers was based on some premeditated idea that for those barriers pieces of pottery would be a better choice than stones. It is more likely that through some chance event a pot broke near the field and the pieces were therefore used.

Based on the material presented in this chapter, and especially the above examples, it may be concluded that adaptive management as practiced by Gourmantché farmers involves: (1) strategic thinking based on agronomic knowledge and subsistence needs, (2) experimentation with new and existing technologies, (3) sequential response to the random vagaries of environmental and socio-economic production constraints as well as to changing soil fertility as a result of crop production. In this way, farmers adapt their management in space and time to attain a balance between labor investment, soil fertility maintenance and a good crop production. This kind of adaptive management may explain why farmers manage to maintain and in some cases even improve soil fertility in relation to uncultivated land (chapter 5). It may also explain why, as was argued in chapter 5, most long-term experimental plot studies, which are based on a fixed treatment for each plot, do not reflect the reality found on farmer fields.[125] In other words, why, in contrast to what such studies predict, Gourmantché farmers are able to maintain soil fertility despite long periods of cultivation.

6.5 Conclusions

The chapter began by pointing out that many of the current studies on farmers' knowledge and technologies only provide a limited understanding of local farming practices because they tend to be too static in their approach. It was concluded that studying theories of soil, and the reasoning behind the use of soil and water conservation, would be more revealing than soil taxonomies and descriptions of the physical attributes of technologies. Following this approach, the remainder of the chapter discussed local theories of soil in relation to land use, soil and water conservation practices, and adaptive management.

It was argued that Gourmantché farmers are knowledgeable concerning processes of soil formation and erosion and have a detailed understanding of the role of organic matter in soil fertility. Farmers are also well aware of processes of land degradation and their role as land users in influencing the condition of the soil for better or worse. It was further observed that local farmers make use of an extensive repertoire of soil and water conservation practices, most of which have been in use for several generations. Farmers were found to have a preference for so called agronomic/biological practices that make use of management skills and biological material, while the use of mechanical practices that make use of physical structures seemed to have declined compared to some 30 to 40 years ago. It was argued, based on stories of informants and an analysis of aerial photographs, that this was not an indication of a decline of "traditional" practices, but an adaptation of their use to changing social and environmental conditions.

While both villages had the same repertoire of soil and water conservation practices, in Samboanli, the village with the highest population pressure, more soil and water conservation on bush fields was practiced than in Pentouangou. In terms of gender differences, men were found to apply more organic matter in the form of household refuse,

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[125] Richards (1989: 40) takes this one step further and suggests that conventional agricultural research will have hard time dealing with such "performance" issues, because trials and experiments are based on replication and comparison, while "the issues at stake in performance only become apparent when the performance is for real."

manure, and livestock paddocking to their village and compound fields than women. Bush fields were found to receive the least amount of such inputs.

One of the most important points raised in this chapter was that Gourmantché farmers adapt their management practices sequentially in the course of a single growing season, as well as during the cultivation cycle of a field. By adjusting their management in space and time, a balance between labor investment, soil fertility maintenance, and a good crop yield is sought. This involves strategic thinking and experimentation, as well as responses to changing soil fertility and unpredictable environmental and socio-economic production constraints. Thus adaptive management is a dynamic process of experimentation, fine-tuning, and exploration of new opportunities.

The kind of management practices discussed in this chapter are a major explanation of why, as was shown in chapter 5, soil fertility is maintained or even improved on cultivated fields relative to uncultivated land. A key factor in achieving this feat, is the way Gourmantché farmers apply soil and water conservation practices, that is, at carefully selected times and to carefully selected parts of their fields. There is simply not enough manure, household refuse, crop residues, etc. available to apply soil and water conservation practices on all fields and all parts of those fields. Not to mention the labor constraints with which farmers see themselves faced. In other words, what counts is not the total amount of, for example, manure or mulch that is applied or the total length of stone lines, but the timing and placement of these investments. In other words, it is the management that counts.

Management may be the key-factor in explaining why on-farm surveys may lead to other conclusions than nutrient budget studies (Powell and Valentin 1998). The factor management is precisely a weak point of nutrient budget studies. As was mentioned in chapter 5, for example the Stoorvogel and Smaling (1990) model for sub-Saharan Africa has only a limited sensitivity to management. Also in other models this is likely to be a problem, because management is not only one of the most difficult factors to model, but as Powell and Valentin (1998) argue, also one of the most difficult factors to understand, because of the effects of different management practices on landscape-level nutrient cycles and because of individual variation in the use of management practices, as well as the complexity of the social and biophysical factors that affect these practices. We may add to that the difficulty of capturing, in on-station trials or nutrient budget models, what Richard's (1989) calls agricultural performance: the art of gaining a living out of agriculture through sequential adjustments to unpredictable conditions.

In the introduction to this chapter the question was asked whether "traditional" soil and water conservation practices are on the decline and unable to cope with the changes brought about by rapid population growth, or, whether such claims are a reflection of an incomplete understanding of local knowledge and farming practices? We have argued that because many studies on local knowledge and technologies tend to be static and descriptive in nature, these might indeed not provide enough insights to understand the full complexity and dynamics of local agricultural management. Through a focus on local theories and dynamics, we believe to have at least partly overcome these limitations and produced some insights, that, at least for the Gourmantché, contradict the popular conviction that local knowledge and technologies have not been able to keep pace with population pressure and maintain soil fertility (see for example Vlaar 1992). Since management is indeed such an important factor, attention should not only be paid to knowledge and technologies as has been done in this chapter, but also to the development of the social institutions that guide management decisions, as will be done in the next two chapters.

Plate VII. Termite activity speeds up mulch decomposition

Plate VIII. Permitting regrowth from tree stumps will later accelerate fallow regeneration

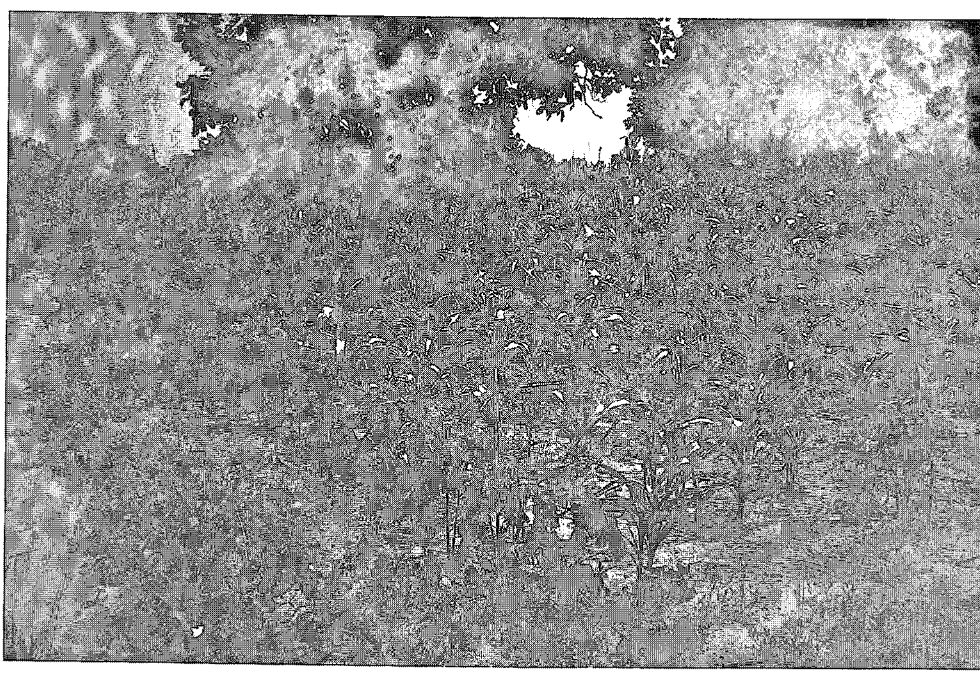

Plate IX. Not all trees are removed from fields

Plate X. Wood barrier on a site suffering from sheet erosion

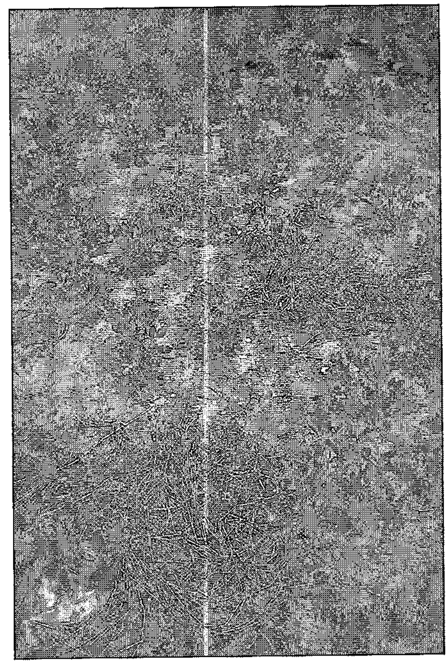

Plate XI. Improving a poor site with decaying weeds

Plate XII. Organic material spread on a village field at the beginning of the rainy season

7. The cultural economy: local economic principles in livelihood decisions

> Goods are neutral, their uses are social; they can be used as fences or bridges. (Douglas and Isherwood 1996: xv)

In the introduction to this book we explained how a narrow, techno-economic focus of studies on soil and water conservation has contributed to the high failure rate of soil and water conservation projects in Africa. While the need for more balanced approaches giving due emphasis to technical, environmental, economic, and social aspects has been generally perceived (Reij *et al.* 1996; Scoones and Toulmin 1998), much still remains to be done in terms of operationalizing and integrating such approaches (see chapter 2). Chapters 5 and 6 have looked at some of the environmental and technical aspects of soil and water conservation. This chapter approaches the social side of soil and water conservation by focussing on the local economy, loosely defined as all that is involved with the allocation of productive and reproductive resources,[126] i.e., livelihood decisions. The reasoning behind this approach is that the way people allocate their resources makes visible statements about the hierarchy of values constituting what "makes sense" in that society (Douglas and Isherwood 1996). Once we gain a better understanding of the principles guiding what "makes sense" in this society (this chapter), we can put soil and water conservation within this context to see if and how it makes sense to conserve soil and water (chapter 8).

This chapter focuses on how the cultural economy in our study region functions in order to gain insights into locally relevant economic principles on which people base their decisions. In section 7.1 we introduce the concept of a cultural economy. In the following section we trace a short history of trade and markets in the study region. In section 7.3 we look into how prices are determined where one would expect market principles to be most prevalent: in market places. Section 7.4 and 7.5 look at receipts and expenditure transactions of 35 case study individuals, highlighting the mixture of market and social principles that guide people's economic decisions. In a final section we look at how the mixture of principles influence how people choose to make their livelihoods.

7.1 The cultural economy

The different approaches that characterize the study of economies in developing countries

[126] Recall that in this study we use the term resources to refer not only to what Harvey (1974) calls resources available "in nature", but also to what farmers are endowed with, and which they can use for productive purposes. Examples are labor, land, money, and technologies.

tend to dichotomize these economies as either "traditional" systems guided by principles of redistribution of opportunities and benefits according to social considerations, or as "wanting" market economies[127] guided by individualistic profit maximizing behavior. We argue in this chapter that this dichotomy is not useful for understanding the mixture of economic principles that results from the particular histories and culture within which economies develop.

There are studies that view economies as driven by principles of reciprocity, solidarity, and mutual assistance (see for example Polanyi 1944; Scott 1976; Hyden 1980). In this view, economies in preindustrial societies, untouched by capitalism, exhibit different morals than those of capitalistic systems. These studies are associated with the "substantivist" school in economic anthropology especially identified with Polanyi (1944, 1957) and (Dalton 1961), and with the "moral economy" approach such as that used by Hyden (1980) and Scott (1976). Granovetter (1985: 482) describes these studies as having an over-socialized conception of human action in which people are "overwhelmingly sensitive to the opinions of others and hence obedient to the dictates of consensually developed systems of norms and values, internalized through socialization, so that obedience is not perceived as a burden."

At the opposite end of the spectrum are those approaches that consider economic behavior to be sufficiently independent of social relations so that economic action and institutions can best be understood as a result of the pursuit of self-interest by rational, atomized individuals, or what Granovetter terms the under-socialized view of human action. Studies using this approach pertain to the "formalist" school in anthropology (see for example Firth 1946; Schneider 1974) as well as political economists, as exemplified by Popkin (1979), who argued against the moral economy approach. Popkin claimed that there are different groups of people within a village, some of whom will be advantaged by local institutions and some who will be exploited by them. He thus emphasized that peasants are not the altruistic actors portrayed in the moral economy approach but rather they are as egoistic and driven by goals of maximum personal advantage as are actors in capitalistic systems.

While neo-classical economics falls under the "formalist" approach, new institutional economics (NIE) developed within the neo-classical economic paradigm (see chapter 2), brought institutions into the limelight of economic studies on developing societies since the mid 1980s. NIE studies focus on the importance of different forms of social organization, such as land tenure systems or social networks (Binswanger and McIntire 1987; Orstom 1990; Platteau 1991; Fafchamps 1992), for the way in which peasants make economic decisions and thus seems to distance itself from the formalist school. However, NIE associates social institutions to subsistence economies because they develop in response to market failures characteristic of such economies (see for example Platteau 1991: 124-125). The underlying supposition continues to be that of the neo-classical paradigm: that is, were these market failures not present, then institutions would be "free" to develop into the "efficient" ones characteristic of a capitalistic system (see chapter 2). For example,

[127] A market economy is characterized by private ownership of land and other goods and in which production and consumption are primarily determined by prices set through free competition.

Binswanger and McIntire (1987) argue, similarly to Boserup (1965), that an increase in population density will lead to privatized land tenure as though that is the only possible development path for land tenure institutions. There is ample evidence, instead, that African land tenure systems have taken on a variety of forms even in highly populated areas (see for example Downs and Reyna 1988).

Whatever the approach, moral or political economy, standard neo-classical or new institutionalist, economies are dichotomized as "traditional" or "market" systems. These two systems are viewed as discrete and incompatible and thus one, usually the latter, ends up dominating the other.

This framework was unhelpful for studying the economy in our research area because of the mixture of different principles at work in guiding people's allocative decisions. We found, similarly to recent anthropological studies of other African systems (Berry 1989; Shipton 1989; Guyer 1997), that "traditional" systems exposed to market economic principles change and adapt institutions to form economies that function on a mixture of principles. This *mixed* system is what we term the cultural economy:[128] that is, the mixture of different allocative principles resulting from the cultural and historical context in which institutions develop. The cultural economy approach focuses on understanding local principles on which an economy is based rather than assume them to be those of a "blueprint" economy. The logic behind the approach is that local economic principles are the pillars with which to understand the reasoning behind people's allocative decisions.

Granovetter (1985) suggests studying social relationships and networks in the analysis of markets and other economic phenomena as a way to avoid making a priori assumptions about economic action as instead do the under- and over-socialized views. Analyzing concrete patterns of social relations, he argues, reveals the details behind the logic of economic action within a society. However, the embeddedness approach has been criticized for focussing too narrowly on social relationships to the neglect of such factors as culture, technology, and the macroeconomic environment (Lie 1997). The approach followed here thus focuses on social relations in economic action but at the same time gives emphasis to the historical and cultural setting in which these relationships take place, that is, the cultural economy.

7.2 A short history of markets

In doing research in rural areas of the eastern region, we were struck by how monetized the society is. There are markets located at frequent intervals throughout the region also in areas far removed from tarmac roads. In budget diaries, people could always cite the monetary value of goods, even those that they received as gifts. People sell surplus production for profit and grain price speculation is a booming activity. These aspects run counter to the images of a moral economy uncaptured by the forces of capitalism. To gain an understanding of how such a "market mentality" came to be, we turn to the historical development of markets and trade in the area.

[128] Term borrowed from Shipton (1989).

7.2.1 Pre-colonial and colonial trading

Historical accounts of trade in West Africa show how the region was widely involved in trade for centuries before the colonial era (Curtin 1975). The Gourmantché were no exception. North-south trading routes connecting the Sahara to the coast have existed at least since the 14^{th} and 15^{th} centuries and reached their peak in the nineteenth century (Levtzion 1968). Some of these routes are said to have passed through the Gourma kingdom, despite the reputation of Gourmantché kings as being dangerous, to connect Say and Gaya east of Gourmantché territory to Salaga to the south. Gold and then kola nuts were brought from the south in exchange for oriental clothing, beads, leatherwork, a limited number of slaves, and natron (Levtzion 1968). Additionally, both village and market histories conducted in the research area refer to trade that occurred with the nearby Mossi to the west and the Fulbe to the north in the nineteenth century (interviews with Tchiara Lankoandé[129] and elders of Tiambargou[130]). Early colonial documents also refer to various markets existing in the area, an active trade between Gourmantché, Mossi and Dioula populations to the west of the eastern region, and trade with caravans on north-south trading routes (COR.AFD.99; RAP.SEM.24; RAP.POL.29; RAP.TOA.37). Furthermore, a document from 1905 (RAP.POL.05) identified eight important trade routes in the area.

Increasingly, historical accounts of trading in West Africa emphasize that pre-colonial currency systems had more “modern” characteristics than was thought in the past (see for example the collection of essays in Guyer 1995b). Goods were often traded in cowry shells (Law 1995) although different parts of West Africa had other forms of local currency such as iron rods, lengths of cloths or iron bowls. These currencies, previously described as special purpose currencies (Bohannan 1959), have actually been shown to have spread throughout entire regions and to have been continuously changing and taking on new purposes throughout the era of the slave trade so as to be much more multi-purpose than previously thought (Guyer 1995a). Cowries, the most widely used currency, did however have complications as a currency. These shells were ultimately imported from the Indian Ocean and brought to West Africa through Europe (Law 1995). There was little control thus over the supply of this currency, creating moments of over-abundance as well as of short supply (Arhin 1995; Law 1995). In the research area one colonial document recounts the virtual standstill of a formerly bustling market due to local populations no longer having cowries to engage in livestock trade with the caravans coming from the north (COR.AFD.99). Furthermore, in large sums, cowries could be quite cumbersome, obliging sellers of cattle, for example, to have to purchase other, more transportable goods to bring home. Cowries were also, in practice, non-convertible to European currencies because European traders would not bring cowries back with them (Hogendorn and Johnson 1986: 111).

[129] Interview on 15 February 1996, Bilanga Yanga.

[130] Interview on 11 January 1996, Tiambargou.

While trade and money[131] were diffuse in pre-colonial times, monetization increasingly affected villagers' daily lives throughout the twentieth century, as documented for other parts of West Africa (Guyer 1995b). Monetization intensified as a result of increased commercial activity and colonial policy seeking to replace the multiple and multi-purpose currencies with single, specialized currencies (Berry 1995). French colonial policy strongly pushed for the adoption of French coins and bills in order to stimulate commerce within the colonies as well as with the mainland as is evidenced by the observations made in all annual reports from the Cercle de Fada to the mainland on the state of adoption of colonial money (for example, RAP.POL.25; RAP.POL.29; RAP.POL.36). Furthermore, colonization brought peace to the wars between the different Gourmantché kings as well as between Gourmantché, Mossi, and Fulbe kingdoms. According to local village and market histories, this resulted in an increase in trade (interviews with Tchiara Lankoandé, elders of Tiambargou).

There were various kinds of products sold in markets around the turn of the twentieth century. Colonial accounts speak of a burgeoning trade of products such as ivory, ostrich feathers, jewelry, cloth, and kola nuts brought by trade caravans coming from the southern coastal countries to the region on their way north (COR.AFD.99) as well as caravans from the Sahelian countries selling salt and livestock on their journey southwards (COR.AFD.99; RAP.POL.29). In the north and west of the eastern region there was also an active trade in local cotton cloth which was dyed locally (RAP.POL.36). In the north of the region cloth was traded with the northern region of Dori and in the west of the region with Togo and the Gold Coast (under English rule). In fact, trade with the Gold Coast was so active that in the 1920s the French colonial authorities complained that inhabitants of the western part of the region were familiar with British coins and did not use French ones (RAP.INS.21/2; RAP.MEN.24). Additionally, regular local markets sold millet, bush and artisanal products, as well as prepared foods such as soumbala cubes used as sauce seasoning and balls of millet flour (*foura*) (COR.AFD.99; RAP.SEM.24; RAP.TOC.39).

The adoption of French currency took some time. Colonial documents dating from 1940 explain that most people still exchanged in cowries (RAP.SEM.40.2). However, as colonial currency became prevalent in later years, the local economy became increasingly integrated with European economies. In fact, villagers describe the latter half of the 1900s as when new markets were created, more products became available in markets, and monetary transactions became a much more frequent phenomenon in people's everyday lives. In general, manufactured products such as western clothing, pre-fabricated pots, as well as modern medicine became increasingly available on local markets and by the 1960s and 1970s commercialization, and the concomitant need for money that it creates, had impacted the day-to-day lives of virtually every villager.

Today, both villages are integrated in a network of markets. In the northern village, villagers regularly use two nearby markets (Bilanga 8 km away and Bilanga Yanga 5 km away). Another market, Piéla (35 km) is used primarily by some men who have means for

[131] Money refers to the objects that serve as a medium of exchange (such as coins, cowries and banknotes) and/or as a store of value (such as bonds or equities) as well as the unit of account with which claims on goods and services are made (such as debts) (Berry 1995).

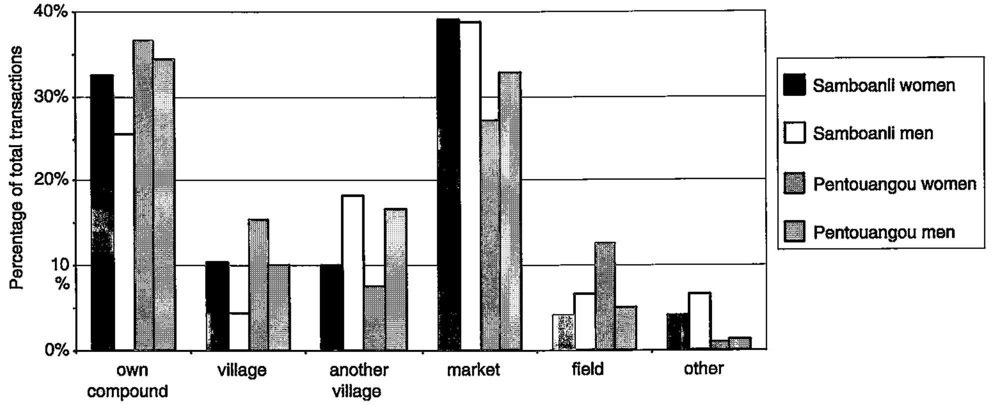

Figure 7.1. Location of transactions, December 1996 to November 1997
Source: Budget diaries.

transport and those involved in commerce and grain price speculation regularly use Pouytenga (55 km). There are also at least 5 other smaller, nearby markets that are visited occasionally as is clear from the budgets of case study individuals. All these markets occur on a three day basis except Pouytenga which exists every day. In Pentouangou, villagers make regular use of Kikideni market (2 km). Men especially regularly visit further away markets such as Nagré (18 km), Fada N'Gourma (15 km), and the livestock market in Fada N'Gourma. Also here the markets occur every three days except for Fada which takes place every day and the Fada livestock market which takes place every Sunday. Additionally, men in the southern village occasionally visit markets along the route to Togo, such as Natiaboani (30 km), and in Togo itself, such as Senkansé (120 km).

Figure 7.1 shows where the transactions of 35 case study individuals took place during the budget year. In the northern research village transactions occurred most frequently in markets and in the southern village they were the second largest category after transactions taking place in one's own compound, showing just how important markets have become in villager's everyday lives.

7.2.2 Local differences in the development of markets

There are historical intra-regional differences in the general trend of increasing monetization and market integration described above. These differences are important because they can help explain some of the differences in resource allocation patterns between the two villages that will be observed in sections 7.4, 7.5, and 7.6 as well as some of the characteristics of the villages highlighted in chapter 4.

One would think that with Fada N'Gourma being the regional capital, markets would be much more developed in the south than in the north. However, as Hill (1966) notes, in West Africa markets abound that are not necessarily close to inhabited centers so that it is not possible to draw the correlation between large cities/towns/villages and the relative importance of a market. This is because the location of market places often develops as a link between ecological zones (Hill 1987) or cultures. The far eastern section, what is today's Tapoa province, seemed to be quite active in livestock trade given its location in the middle of an important north-south trading route linking the Sahara with the coastal countries. More to the west, at the borders of Mossi territory there also seemed to be active trading, especially of cotton in various forms, between the two ethnicities as well as with other colonies. In the area in-between, trade instead seemed to be much less developed. This means that there was a difference between the two study villages in their access to markets.

It results from both village and market histories that Samboanli was involved with markets and trade for a longer time. Samboanli is located only 3 km from Bilam Perga where a market was located. In the mid of the nineteenth century the inhabitants of Bilam Perga had a dispute over chieftaincy and split. One part of the population fled to Boulsa and then returned to raid the other part of the population which, in turn, fled to Liptougou. Once their conflict was resolved by the end of the nineteenth century, each population returned to Bilam Perga but did not want to settle in the original place. Thus one part settled in Bilanga (8 km) and the other in Bilanga Yanga (5 km). Both re-established markets in the respective villages (interview with Tchiara Lankoandé). At first, both markets were quite small (interview with Tchiara Lankoandé; RAP.TOC.15/283) but by the early 1900s Bilanga Yanga had become quite important, attracting Mossi populations from as far as Kaya. In 1937 the Commandant de Cercle Garnier described it as a bustling market that met every three days (RAP.TOA.37). Garnier reports bush and small artisanal products as the most important products being sold. In the same report he mentions that the Bilanga market was relatively unimportant. In a report of 1954, Commandant Delagrange describes Bilanga Yanga as one of the most important markets of the Cercle in which manufactured goods, agricultural produce and small stock are bought and sold (RAP.TOA.53-54). Accounts speak of Mossi who came to trade in cotton in this area (RAP.POL.36). The Mossi are regarded by the Gourmantché for their entrepreneurial spirit. An indication of how important this trade was for them, is that village histories for Samboanli and a nearby village Tiambargou, as well as the market history of Bilanga Yanga all mention how disruptive the wars with the Mossi were for trade. Today, Bilanga Yanga market continues to be one of the more active local markets. It has developed an important link with one of Burkina Faso's most important markets, Pouytenga (55 km), in Mossi territory, reputed for its black-market items. Merchants come to Bilanga Yanga to purchase agricultural products to furnish Pouytenga market. Conversely, a large number of products sold in Bilanga Yanga come from Pouytenga, making it the local market with the greatest variety of products.

Despite the fact that Pentouangou is only 15 km from Fada N'Gourma, the home of the king of the Gourmantché, later to become the colonial headquarters, and finally the regional capital, trade was less developed than in the area of Samboanli. At the time of colonization there were various Gourmantché kingdoms. Although they were all under the authority of the king of Fada N'Gourma, these kingdoms were quite independent and even waged wars against each other (Madiéga 1993). Thus the decision to make Fada N'Gourma the regional colonial headquarters was not based on a pre-existing dominant political or economic balance of power. In fact, at the beginning of the twentieth century Fada N'Gourma had a small, unimportant market (RAP.SEM.24; RAP.POL.25; RAP.POL.29). Furthermore, the area south of Pentouangou, in the direction towards Togo and Benin, was up until the Second World War a forest known for its wild animals and difficult territory to travel. Colonialists trying to find good routes in the area also describe this as impenetrable territory (RAP.MON.03) and note that the existing route towards Togo and Benin was hardly used by the local population (RAP.POL.36). Part of this territory is today a nature reserve and stories still abound about the evil spirits that inhabit that area. The haunting deaths of five Europeans, in two separate incidents, that occurred while we were there, only confirmed these stories. This impenetrable and dangerous territory caused the southern part of the region to have few markets that were to a large extent addressing very localized needs. In oral histories collected in Pentouangou, reference is made to a village some 20 km away to which they would go to get their earthen pots. Blacksmiths were located in the village itself and for the rest, the village was quite self sufficient. There were traveling Djarma, known for their courage in facing the forest to hunt wild animals, who would sell dried meat from village to village (interview with Foldjoa Thiombiano[132]).

After independence Fada N'Gourma retained its role as regional capital and became home to regional government offices as well as to non-governmental organizations and development projects. The guns that become available as the "tirailleurs" came back from various wars (World War I and II, and Indochina) and the improvements to the route to Pama under Colonial rule, caused the wildlife population in the forest south of Pentouangou to decline and opened up communication with Togo and Benin. The hospital in Fada N'Gourma was created in the late 1960s. In the 1970s the daily market in Fada N'Gourma increased in size and began attracting traders from beyond the immediate vicinity. In 1979 the livestock market, one of the nations' top five, came into existence. Finally, the road connecting Fada N'Gourma to Togo and Benin, passing 4 km west of the southern village was asphalted only in 1993. Thus Fada N'Gourma, as we know it today, is a very recent development. This means that the increase in importance of markets in villagers' daily lives prompted by the growth of Fada N'Gourma, occurred much later than in Samboanli and at a time when a nearby semi-urban population was developing.[133]

The difference in the history of market integration between the two villages helps explain some of the differences in characteristics that were observed in chapter 4. Markets are not only places where goods and services are exchanged but also where people meet. The greater trading activities in the north brought Samboanli into greater contact with both Mossi and Fulbe populations than Pentouangou. We see this in the characteristics of the two villages' populations: over 50% of married Gourmantché in Samboanli speaks two or more languages whereas in Pentouangou only 30% does. In Samboanli, 69% of married Gourmantché claim to be Muslim, a religion closely associated with commerce, compared with only 4% in Pentouangou. In Samboanli just under one quarter of the households had at least one inter-ethnic marriage between Gourmantché, Mossi and/or Rimaïbè whereas in Pentouangou not one.

Samboanli's longer history with markets contributes to its generally more outward orientation than Pentouangou. The greater outward orientation is also reflected in the migration patterns that we saw in chapter 4 in which the Gourmantché population of

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[132] Interview on 26 February 1997, Pentouangou.

[133] In 1996 Fada N'Gourma had a population of 29,254 (INSD 1998).

Samboanli was found to have started migrating earlier, in greater numbers, for longer periods, and over greater distances than in Pentouangou. More recently, however, migration has increased in Pentouangou mirroring the rapid trends in recent market integration described.

In summary, trade and markets have been in existence in the research area for over a century and most likely longer. However, when we move down to the scale of the research villages, we note differences in how trade developed between the northern and the southern parts of the research area. In the north, trading has been more important for a longer time than in the south. Furthermore, when markets began to have a daily influence on villagers' lives, the southern village was also close to a burgeoning nearby, semi-urban population. These simultaneous developments, as we will see in sections 7.4, 7.5 and 7.6, provides an important explanation for the differences in livelihood decisions made by villagers in the northern and southern village.

7.3 Prices in marketplaces

The large role of markets and trade in people's lives that have been described above, however, is not an indication that market principles govern all aspects of livelihood decisions. Market-like transactions interweave with non-market principles. For example, bride price is still paid in cloth, livestock, and labor but it now also has a monetary component to it, people contribute labor to work parties for which they receive no monetary compensation yet at the same time they sell surplus production for profit, they redistribute grains and meat at funerals, marriages, and baptisms yet at other times they sell their grain when others most need it in order to get the highest price for it. We therefore collected several different types of information in order to gain a better understanding of what principles guide people's livelihood decisions.

A one-year price allocation study was conducted to see to what degree market principles are applied in transactions taking place in marketplaces, where one would expect them most to apply. Purchase prices were recorded, taking note of the relationship between the buyer and the seller. This study was conducted at Bilanga and Bilanga Yanga markets in the north and Kikideni and Natiaboani markets in the south and included 27 types of edible products and household utensils ranging from prepared foods to coarse grains, from fruits to ladles made of calabash. Table 7.1 shows that prices stated by sellers, that is prices at which no discounts are offered, were actually paid in just over 60% of the cases. In the remaining 40% of transactions, discounts were given. Of these discounts the highest were given to kin relations and lower discounts were given to friends. Over half of the discounts given were 50% or more off of the stated price. Table 7.1 therefore indicates that the relationship between the vendor and the buyer plays an important role in determining the sale price. Note, instead, that market surveys usually record the prices stated by sellers and therefore miss a large percentage of the prices at which products are actually sold.

In order to understand how pricing of items worked for the 60% of transactions in which no discount was given, a market survey was conducted in which prices stated by sellers were recorded for various products in four markets in the northern and southern research locations (chapter 3). Both areas exhibited a small price differential for the main

Table 7.1 Price discounts given in markets, recorded between May 1996 and August 1997

Relationship between buyer and seller	N	Proportion of transactions in which: No discount was given (%)	A discount was given (%)	A gift[a] was given (%)
No relation	403	80	20	0
Friend	116	31	61	8
Family	52	4	37	60
Total	*571*	*63*	*30*	*7*

Significance

Chi square = 346 with 4 degrees of freedom

$p < .01$

Source: Price allocation survey.

[a]The term gift is used in cases where things were given free of charge, i.e., a 100% discount.

unprocessed crops[135] within the same market. The largest price differential was recorded for groundnuts and maize in one market with an average deviation from the mean price offered by sellers on any given market day of about 4% for the two-year period in which prices were recorded. The remaining products averaged between 0.1% and 3.1%. This indicates that sellers' stated prices do abide to some extent to the laws of supply and demand, otherwise one would expect to find a much greater variety of prices with vendors in alike markets taking advantage of buyers and over-charging to varying degrees for their products. Both of the above results seem to imply that there is a mixing of market and non-market principles in the way that the local economy functions. We now turn to an analysis of 35 individuals for a more in-depth analysis of how this mixture of principles affects people's livelihood decisions.

7.4 Budgets and livelihoods

This section and the following one focus on the considerations behind allocative decisions. This is done by looking at inflows and outflows[136] in people's budgets. Section 7.4.1 looks at own crop production, including what people consume. Sections 7.4.2 and 7.4.3, instead, look at all that is received and used, above and beyond what is consumed of one's own crop production. This is referred to as people's surplus. The reasoning behind this approach is that how people gain and use surplus gives insight into how they make a living as well as on the values and material constraints and opportunities that guide what makes sense in such a society (Berry 1989). In order to distinguish between the analysis in section 7.4.1 that includes produced and consumed own production and the following sections in which produced and consumed own production is excluded, we refer to the former as total inflows and outflows and the latter as total receipts and expenditures.

[135] These were the crops millet, sorghum, cowpeas, groundnuts, rice and maize.

[136] Gittinger's (1982: 479) definition of inflows is used to refer to all payments, goods, and services that are received or produced by an individual. Conversely, outflows refers to all payments made and goods and services given to another entity (Gittinger 1982: 490).

The analysis is based on various sources. Budget diaries collected on a bi-weekly basis for 35 case study individuals over a period of two years are combined with information collected from a three-year stock survey. For both data sets, only one year is analyzed, ranging from December 1996 to November 1997 (see chapter 3 for explanations). Furthermore, the data are supplemented by information obtained through interviews and observation.

The data from the diaries and survey are presented on a per-person basis rather than summarized as averages for different classes of people. This is done for several reasons. First, the data present case study information. The cases are too few to produce statistical analyses in which people are categorized into groups and deviations from a mean are calculated. Second, the rather unique quality of the budget data collected for this study is the equal attention given to both men and women. Data were obtained from household heads, their wives, as well as other married individuals within that household. Typically, instead, surveys looking at people's receipts and expenditures will obtain data from household heads thus treating the household as a homogeneous unit (for example Ellsworth 1988; de Steenhuijsen Piters 1995; Clay *et al.* 1998), or, if women are considered, only a token few are questioned relative to the rest of the sample (for example Matlon 1988; Guyer 1997). At the opposite extreme are studies that focus uniquely on women's resource allocation (for example Hemmings-Grapihan 1985; Waters-Bayer 1988; Moore 1996) to the exclusion of men. Thus presenting the data from this study on an individual basis gives insights into intra-household dynamics of resource allocation.

The main unit of analysis is the transaction[136] of which not only the monetary value and timing is looked at, as is customary in economic analyses, but also the relationship between those engaging in the transaction. Special care has been taken all along the data collection process to give due attention to social transactions, that is, the giving and receiving of gifts and the purchases or selling that is done related to them. This is because, as will be argued in section 7.5, the nature of these transactions makes it very difficult to capture them fully through large-scale surveys and are subsequently frequently underestimated, if given any consideration at all. In the remainder of section 7.4 all receipt and expenditure categories will be discussed that are not related to social transactions or loans. Section 7.5 instead focuses on social transactions while a portion of section 7.6 discusses loan transactions. Given the sensitivity of the information, pseudonyms have been used for people's names whenever budgetary data are presented.

Because the analysis is conducted for only one budget year, it is important to say something about what kind of year it was in terms of harvests so as to place the observed patterns of receipts and expenditures within context. For example, people's spending patterns most likely differ in a good harvest year from that of a bad harvest year. In chapter 5 we have seen that rainfall is the largest determinant of crop production. We, therefore, first turn to how rainfall was during the budget year. Rainfall in 1996 was 743 mm in Bilanga compared with an average of 646 mm for 1970 to 1998. For the same period, rainfall in Fada N'Gourma was 724 mm compared with an average 800 mm between 1970

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[136] We use the term transaction to indicate the act between two or more people who exchange goods, services, gifts, or money.

and 1998.[137] An analysis of how rain was distributed throughout the season shows that both areas received relatively more rain in September and October than for the 28-year average. Comparing provincial millet and sorghum yields in 1996 with those in preceding years (1992-1995), we see that sorghum yields were above average whereas millet yields were slightly below average in the Gnagna province and sorghum yields were well below average and millet yields average in the Gourma province. However, when comparing the yields measured for some of the case study individuals, we note that some people fared better than the 1996 provincial averages and some worse. Irrespective of these statistics, each individual compares his or her harvest with what they obtained in previous years. This indicates that probably the most correct way to judge what kind of year it was is to base it on farmers' judgements. In both Samboanli and Pentouangou, millet and sorghum producing household heads were reasonably satisfied with their production and in Pentouangou rice cultivating farmers were very happy with their rice production. This shows that deciding what kind of a year it was can be quite complex and depends on the person. But in order to place the following analysis in context we can conclude that 1996 was neither a particularly bad nor an exceptionally good year but an average year, slightly leaning towards good.

7.4.1 The role of arable farming

Arable farming is the most important contributor to subsistence needs. Virtually every villager except for the extremely old, young, or handicapped, is involved in crop cultivation from which they obtain food. The primordial importance of arable farming is also reflected in the fact that Gourmantché adults in both villages define themselves as first and foremost farmers. Even someone such as Bandia who is heavily engaged in livelihood activities other than crop cultivation, defines himself as a farmer. In concurrence with this we observed that when judgements were made by villagers about other villagers, a reference was often made to his (we have this information only for men) quality as a cultivator, i.e., how much effort he put into arable farming. Even a successful merchant will be judged negatively if his fields are in a bad state due to his lack of effort. Almost everyone considers him or herself fit to cultivate. Even old men and women, too old to stand for a long time, will cultivate in a sitting position. Blindness does not prevent people from cultivating in some cases. In each village there are only a handful of people who are too old and too sick to get out of their compound to cultivate a little. This illustrates the importance of cultivation for the Gourmantché identity.

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[137] These meteorological stations are the closest to the research villages: 5 km and 15 km from Samboanli and Pentouangou, respectively. Comparing data from the meteorological stations with the June-October rainfall data that we collected from gauges in various positions in the study villages, Samboanli data corresponded well with the Bilanga data whereas Pentouangou measurements fell between 50 to 200 mm below the Fada N'Gourma data in 1996.

Table 7.2 Crop production of case study individuals in Samboanli, 1996

Cmp.[a]	Hh.[b]	Name (relationship)[c]	Total crop production[d] (current fcfa)	Proportion of total crop production: Consumed[e] (%)	Marketed (%)	Other[f] (%)	Total inflow[g] (current fcfa)	Crop production as % of inflows (%)
				Women				
S1	A	Yempousa (wife 1)	48,088	33	64	3	103,511	46
		Folpoa (mother)	30,017	7	93	0	71,774	42
S2	B	Oureta (wife 3)	63,475	24	75	1	115,235	55
S2	C	Dahani (wife 1)	137,558	5	91	4	435,217	32
		Miabala (wife 2)	94,899	29	69	2	186,951	51
		Dapoa (wife 3)	79,188	12	79	8	148,169	53
S3	D	Podiandi (wife 1)	45,124	20	76	4	80,248	56
S3	E	Possi (wife 1)	78,419	9	91	0	155,736	50
		Sacou (wife 2)	57,139	11	79	10	109,085	52
		Mindiba (mother)	50,600	84	16	0	109,984	46
				Men				
S1	A*	Bandia	223,072	97	2	1	400,649	56
S2	B*	Hambila	1,574,658	54	36	9	2,426,377	65
S2	C*	Piampo	495,935	72	24	4	746,793	66
S3	D*	Konkoari	210,386	93	6	0	240,493	87
S3	E*	Yabre	228,090	89	7	4	321,095	71

Source: Stock survey and budget diaries.

[a]Compound code; alike numbers indicate members of a single compound.

[b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head.

[c]Relationship to the head of household. Nothing is marked for the household head himself.

[d]Calculated using market prices at the time that production was used.

[e]Calculated using market prices at the time that production was consumed. These figures include what was used by the household for food as well as what was set aside for seed for the following agricultural season.

[f]This category consists uniquely of gifts given of own production.

[g]Inflows include own production plus all in-cash and in-kind receipts itemized in table 7.4.

Tables 7.2 and 7.3 show how important people's own agricultural production is in terms of providing food for their families.[138] According to the customary division of household tasks, the head of a household is responsible for providing the food needs of the household. In both villages, between 70% and 99% of what is produced on non-rice producing, case study, household heads' fields is consumed by the household (with the exception of the by far wealthiest man, who consumed 54%). This figure, instead, is much lower for rice producing, case study households of Pentouangou, because rice is mainly used as a cash crop and the income received is used in large part to purchase millet and sorghum for consumption, as will become clear in table 7.5.

[138] This is true even though the consumed own production figures are most likely an underestimation given the underreporting of crops that are consumed right as they are harvested such as maize or some of the minor crops such as rosella, okra, soya, and Bambara groundnuts.

Consumed own production was low for most women and old and young men who, given the customary division of household tasks, are not responsible for providing for their household's consumption needs. The consumption of women's production consists mainly of sauce ingredients or of groundnuts which are often given to children to gnaw on or to

Table 7.3 Crop production of case study individuals in Pentouangou, 1996

Cmp.[a]	Hh.[b]	Name (relationship)[c]	Total crop production[d] (current fcfa)	Proportion of total crop production: Consumed[e] (%)	Marketed (%)	Other[f] (%)	Total inflow[g] (current fcfa)	Crop production as % of inflows (%)
					Women			
P1	A	Taala (wife 1)[h]	5,354	100	0	0	38,684	14
		Aminata (sister in law)	5,354	100	0	0	28,972	19
		Larba (mother)	17,759	76	23	2	47,820	37
P1	B	Aibibatou (wife 1)	16,229	15	85	0	140,081	12
		Tembendi (wife 2)	5,663	0	70	30	43,040	13
P2	C	Kilpoa (wife 1)	24,372	37	20	43	59,124	41
		Potaga (mother)	0	0	0	0	10,955	0
P2	D	Kayaba (wife 1)	8,913	19	81	0	33,930	26
P3	E	Lamousa (wife 1)	13,851	46	50	3	43,433	32
		Noro (wife 2)	9,585	18	65	17	46,061	21
		Valga (sister in law)	9,274	47	39	14	37,711	25
					Men			
P1	A*	Djoulmani	647,800	3	87	10	1,286,912	50
		Dossi (brother)	160,165	12	83	5	392,794	41
		Laya (father)	66,199	33	56	11	232,949	28
P1	B*	Ahandi	408,168	70	29	1	713,803	57
P2	C*	Noaga	169,600	95	4	1	204,151	83
		Diakiro (father)	39,738	73	21	5	156,719	25
P2	D*	Babrile	145,759	99	1	0	165,826	88
P3	E*	Sambo	140,494	82	15	2	172,731	81
		Marhi (brother)	245,770	17	76	6	476,995	52

Source: Stock survey and budget diaries.

[a]Compound code; alike numbers indicate members of a single compound.

[b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head.

[c]Relationship to the head of household. Nothing is marked for the household head himself.

[d]Calculated using market prices at the time that production was used.

[e]Calculated using market prices at the time that production was consumed. These figures include what was used by the household for food as well as what was set aside for seed for the following agricultural season.

[f]This category is predominantly gifts given of own production but also includes loans, feed for chickens, and in one case (Tembendi), what was eaten by goats after breaking into the granary.

[g]Inflows include own production plus all in-cash and in-kind receipts itemized in table 7.5.

[h]Taala and Aminata cultivate one field together so their total and consumed agricultural production figures have been divided equally amongst them.

make sauces. In the case of Yempousa, Podiandi, and Lamousa quantities between 20 kg and 60 kg of millet or sorghum were consumed. These are wives in poorer households who need to help their husbands make ends meet. The four women who have exceptionally high consumption of their total production are Taala, Aminata, Larba and Mindiba. The first two are young women who cultivate very little for themselves and their household consumed all of their production (groundnuts). The second two are mothers of the household head showing that the production of elderly women who still cultivate can be tapped in order to make ends meet.

Arable farming, however, is not only a means of subsistence. As we can see from tables 7.2 and 7.3, people do not consume all of what they produce. Some of their production is sold and some is given in the form of gifts and loans. It is also important to note that some of the male case study individuals had total inflows of more than the average salary of 25 to 30 thousand fcfa per month of a state employee in the lowest pay scale (scale E which requires no schooling such as for a janitor or gardener). This runs counter to the general perception amongst development practitioners that villagers are poorer than urban dwellers.

Furthermore, these tables show that crop cultivation can comprise as much as 81% of total inflows but also as little as 12% (excluding Potaga who does not cultivate). Thus crop cultivation is only one activity contributing to people's total inflows. We now turn to the analysis of people's surplus to gain a better understanding of how they earn their livelihoods.

7.4.2 How do people make a living?

Arable farming

We now turn to the analysis that excludes consumed own production. Tables 7.4 and 7.5 show the categories of total receipts of the 35 case study individuals over a one-year period. One of the most striking characteristics is the overwhelming importance of crop cultivation as a source of income in both villages.

However, there are differences in the importance of arable farming in the two villages. First, in Pentouangou, individual men's earnings from crop cultivation can be substantially higher than in Samboanli. This is because in Pentouangou rice is cultivated on the village territory and it is primarily a cash crop. Three of the nine case study men in Pentouangou grow it and it accounts for their large inflows from crop cultivation. For case study men in Samboanli, if one excludes the exceptional case of Hambila, income earnings from crop cultivation are lower as it is too dry to grow rice on village territory. A development project created irrigated rice plots at the beginning of the 1990s about 5 km from the village. The distance, the cost, and the fact that there is a limited number of plots, makes it so that only few men in Samboanli grow rice. In Samboanli, there is no large-scale alternative cash crop. Hambila, with the highest agricultural earnings among the case studies and possibly in the village, is an exception because he owns a mango orchard and has enough labor (6 wives!) to grow large quantities of sweet potatoes, both of which helped him to earn over 350,000 fcfa in the budget year.

Table 7.4 Receipts of case study individuals in Samboanli, December 1996 to November 1997

Cmp.[a]	Hh.[b]	Name (relationship[c])	Crop prod.[d] (%)	Livestock (%)	Off-farm (%)	Social transactions: Ceremony (%)	Social transactions: Other gifts[e] (%)	Social transactions: Loans[f] (%)	Total (fcfa)
						Women			
S1	A	Yempousa (wife 1)	55	7	21	10	6	0	55,424
		Folpoa (mother)	67	1	8	3	22	0	41,757
S2	B	Oureta (wife 3)	98	0	0	0	2	0	51,760
S2	C	Dahani (wife 1)	42	9	48	0	0	0	297,660
		Miabala (wife 2)	71	23	1	3	1	0	92,052
		Dapoa (wife 3)	94	0	2	0	1	4	68,982
S3	D	Podiandi (wife 1)	98	0	0	0	2	0	35,124
S3	E	Possi (wife 1)	92	0	2	1	4	0	77,317
		Sacou (wife 2)	87	0	5	1	7	0	51,947
		Mindiba (mother)	85	0	8	0	6	0	59,384
Average per woman			*79*	*4*	*9*	*2*	*5*	*0*	
						Men			
S1	A*	Bandia	5	34	0	20	13	28	177,577
S2	B*	Hambila	68	11	7	3	1	10	851,719
S2	C*	Piampo	51	39	2	3	3	2	250,858
S3	D*	Konkoari	44	0	3	4	33	15	30,107
S3	E*	Yabre	18	9	48	12	5	9	93,005
Average per man			*37*	*19*	*12*	*8*	*11*	*13*	

Source: Budget diaries.

[a]Compound code; alike numbers indicate members of a single compound.

[b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head.

[c]Relationship with respect to head of household. Nothing is marked for the household head himself.

[d]Crop production does not correspond perfectly with marketed own crop production reported in table 7.2 which was based on the stock survey because this category also includes agricultural gifts that women receive and then sell and the second harvest that women get by going through a harvested field a second time (which was not reported in the stock survey). This category also includes sesame harvests that were underreported in the stock survey.

[e]Those gifts that are received outside the realm of ceremonies.

[f]Loans the case study individual received and loans that were paid back to him/her.

The inverse is true for women: agricultural earnings are greater in the northern village than in the south. This helps explain why on the whole, women's receipts are greater in Samboanli of those of Pentouangou. These figures reflect the different histories of women's entry into agriculture in the two villages. Traditionally, Gourmantché women did not cultivate their own grain fields (interviews with Bernard Lompo,[139] Mindiba Lankoandé and other elderly women,[140] and Bandienpua Thiombiano and wife of Sonkieba Nassouri[141]). The greater historical market involvement in the north, however, made women become full

[139] Interview on 11 April 1997, Fada N'Gourma.

[140] Interview on 6 March 1996, Samboanli.

[141] Interviews on 5 March 1996 and 11 March 1997, Pentouangou.

participants in agricultural tasks a few decades before their southern counterparts. The history of this process is described in detail in chapter 8 and the consequences are drawn for how women access resources.

Table 7.5 Receipts of case study individuals in Pentouangou, December 1996 to November 1997

Cmp.[a]	Hh.[b]	Name (relationship[c])	Crop prod.[d] (%)	Livestock (%)	Off-farm (%)	Social transactions: Ceremony (%)	Social transactions: Other gifts[e] (%)	Social transactions: Loans[f] (%)	Total (fcfa)
						Women			
P1	A	Taala (wife 1)	29	15	21	0	27	8	33,329
		Aminata (sister in law)	32	0	42	0	23	3	23,318
		Larba (mother)	29	3	12	0	39	16	30,061
P1	B	Aibibatou (wife 1)	17	18	44	0	11	10	123,852
		Tembendi (wife 2)	19	0	24	0	40	17	37,377
P2	C	Kilpoa (wife 1)	40	13	7	0	34	6	34,753
		Potaga (mother)	4	0	5	0	91	0	10,955
P2	D	Kayaba (wife 1)	29	21	0	0	36	14	25,016
P3	E	Lamousa (wife 1)	50	0	34	0	7	9	29,581
		Noro (wife 2)	27	1	38	0	30	5	36,476
		Valga (sister in law)	29	28	7	0	26	11	28,437
Average per woman			*28*	*9*	*21*	*0*	*33*	*9*	
						Men			
P1	A*	Djoulmani	88	1	1	0	4	6	639,112
		Dossi (brother)	57	19	4	0	6	14	232,629
		Laya (father)	22	20	11	0	13	34	166,750
P1	B*	Ahandi	38	18	28	2	2	13	305,635
P2	C*	Noaga	20	4	23	0	27	26	34,552
		Diakiro (father)	7	8	18	0	5	61	116,982
P2	D*	Babrile	4	0	8	0	53	34	20,067
P3	E*	Sambo	75	0	0	0	16	9	32,237
		Marhi (brother)	85	10	0	0	5	0	231,225
Average per man			*44*	*9*	*10*	*0*	*15*	*22*	

Source: Budget diaries.

[a]Compound code; alike numbers indicate members of a single compound.

[b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head.

[c]Relationship with respect to head of household. Nothing is marked for the household head himself.

[d]Crop production does not correspond perfectly with marketed own crop production reported in table 7.3 which was based on the stock survey because this category also includes agricultural gifts that women receive and then sell and the second harvest that women get by going through a harvested field a second time (which was not reported in the stock survey). Furthermore, given the particular way the brothers of household 3E manage their funds, they each reported receiving agricultural gifts from the other and then selling them. These gifts thus do not appear as being marketed in the stock survey.

[e]Those gifts that are received outside the realm of ceremonies.

[f]Loans the case study individual received and loans that were paid back to him/her.

Aside from the importance of arable farming, tables 7.4 and 7.5 show that most people have receipts coming from a variety of sources. These other sources are livestock, off-farm, gifts received and debts repaid. Below we will discuss the first two categories.

Livestock

An important income earning activity is livestock rearing. Livestock was primarily sold in cases of livestock fattening activities when an animal is bought, fattened, and then resold, or in cases in which cash was needed to pay for ceremonies (plate XIV).

Women tend to have small stock and poultry if any livestock at all. In the southern village the selling of livestock among case study women was due to a niche that was discovered shortly before we began our research: buying of small pigs, fattening them during the dry season, and reselling them before the rains. As piglets cost between 1,500 and 1,750 fcfa just after the 1996 harvest, this was an activity that women could engage in even with their low incomes. In the northern village women were not engaging in livestock fattening activities. The three women who sold their small stock did so either to buy cattle, or, more commonly, to pay for a ceremony such as the funeral of a natal family member. Dahani, who exceptionally in 1996 and 1997 tried to engage in livestock fattening, was disappointed with it as an income earning activity. As she cultivates in a bush field and does not dispose of the means to bring crop residues back to the village, she had to rely on purchased feed for her calf. By the middle of the dry season she had already spent on feed above what she could earn in benefits from selling the calf.

Selling of livestock tends to be a more important source of income among men in the northern village. This reflects the greater quantities of cattle owned by men in the northern village than in the south. Exact figures are impossible to come by given the sensitivity of the topic, but interviews with men in both villages about the total numbers of livestock owned by the Gourmantché populations reveals greater quantities of cattle in the north. This is confirmed by the figures we were able to get from the case studies. The man with the most cattle amongst the case studies in Samboanli had more than four times the cattle than his equivalent in Pentouangou. Furthermore, a higher percentage of case study men had cattle in Samboanli and they all, except one, owned more cattle than the men who had cattle in Pentouangou. Most of the income earned from livestock among southern men came from selling meat of animals butchered due to illness. The reason for these differences in animals owned between the two villages lies in the historical context in which Gourmantché-Fulbe relations evolved. These will be discussed in detail in the next chapter.

Off-farm activities

In both villages women earn proportionately more from off-farm activities than men. Furthermore, off-farm activities are practiced by virtually all women: of the 21 female case studies only three women did not engage in any off-farm activities. Women engage in activities such as selling prepared foods (plate XIII), bush products, tobacco, and kola nuts and brew beer. In general, wealth and life cycle affect what activities they can conduct.

Poorer and younger women engage in those off-farm activities that do not require large monetary or capital investments; the former because they do not have the resources and the latter because they have not yet accumulated the resources to make such investments. These women can engage in activities such as selling bush products (locust beans, baobab leaves, and shea nuts) and their by-products (locust bean cakes, shea butter, see plate I). In the case of young women, even the by-products are difficult because they require time, which they often do not have when raising young children.

A notable difference between the two villages is that the southern village has more bush from which bush products can be collected and sold. In this sense, the southern village offers more off-farm income earning opportunities to young or poor women. Furthermore, as was explained above, the southern village has a nearby, semi-urban population who will buy these products. These factors are reflected in the fact that off-farm activities are more important in terms of the percentage of total inflows that they provide for southern women as compared with northern women.

Petty trade and beer brewing, instead, are off-farm activities that women engage in that require resources. Women are therefore more likely to be able to engage in these when they are at a later stage in their life cycle, if ever. Petty trade requires children who are old enough (about six years old) to go from compound to compound to sell the products the women make. Female children are also necessary to take over household tasks from a woman in order to give her time to make the goods to sell, but also to go from compound to compound to reclaim the debts owed her. Beer brewing requires a certain wealth because of the earthen jars necessary for brewing as well as a cart and donkey needed for collecting wood.[142] Furthermore, women need to have surplus production with which to obtain the grain needed to make beer. In fact, we observed that beer brewing tends to be done by women in their middle age and in relatively well-off households as is the case of Aibibatou, for example.

Men also engage in off-farm activities but to a lesser extent than women. The primary off-farm activities men engage in are petty trade, commerce, buying and reselling of grain, tailoring, weaving, gold digging (in the north), and transport with carts (in the south).

Three things make for high earnings in off-farm activities: skills, wealth and a bit of luck. The highest earners of off-farm income amongst the case studies are those who possess a special skill with which they found a niche: Dahani teaches, Yabre fixes radios, Ahandi tailors, Aibibatou brews beer. Ahandi, Dahani and Hambila all buy and resell grain, an activity that requires a certain amount of money.

Dahani is an exception because she earns more than all male and female case studies with off-farm activities but she exemplifies the necessary ingredients for earning well from off-farm activities. She had four fortunate things happen to her. She was the fifth daughter of her father, born at a time when the French administration imposed on parents to send their children to elementary school, she married into a well-to-do household, and she did not have a child for the first eight years of her marriage. As she was the fifth daughter she could be easily spared by her family to go to school and was thus the one chosen to attend

[142] Lots of wood is required for making beer and in both villages obtaining these quantities of wood is greatly facilitated by the use of a cart and donkey to transport the wood from the bush to the village.

the mandatory French school. In this way she became literate. She later married into a wealthy family. She and her husband went to cultivate from a bush compound the first years after their marriage. They did not have children for the first eight years after their marriage (due to miscarriages) so she was able to work hard on her grain and groudnut fields. She sold her production and after the eight years of cultivating she was able to buy her first calf. It was a famine year (1983) so she was able to buy livestock cheaply from a Fulbe. Three years later she sold the calf, by now a cow, and bought a weaving machine. The wife of a school teacher in a nearby village taught her to weave so during the dry season she sold the cloth she made. After two years she decided to buy a donkey drawn plow. By 1989 she had three young children so she no longer had time to weave. She sold the weaving machine and bought a donkey. In 1996 a local NGO working on literacy trained her as a local teacher in the Gourmantché language from which she now earns an income of between 25,000 and 30,000 fcfa, most of which she gives out as gifts to her husband, his family, and her natal family. Her other income earning activities are buying grain and groundnuts to resell later in the season when prices are at their highest and buying cattle through her husband. In essence, Dahani had skills, wealth, and luck, all of which contributed to her being able to earn well from off-farm activities.

Migration remittances were virtually negligible among all the case study individuals. This finding is similar to another study in Burkina Faso by Reardon *et al.* (1992) but counter to the migration literature which tends to highlight the importance of migration remittances (Rosenzweig 1988 in Reardon 1992) and to the findings by Breusers (1999) on the importance of migration remittances among the Mossi. We found however, that amongst some of the case study men aged between 40 and 50, migration income had been nonetheless important for them to establish their families and their wealth upon their return. Bandia migrated regularly to the Ivory Coast for 9 months of the year between 1978-87 where he worked on cocoa and coffee plantations and in a pineapple factory. With his migration money he was able to buy 7 cattle, 1 plow, 3 donkeys, sheep and 2 motorbikes. He was able to go on migration because his parents were still strong and his wife had only one child to care for so that all people that he left behind could cultivate for themselves. Piampo migrated to Ivory Coast between 1966-73 where he was employed as a player on a local football team. Although he spent much money to pay for his return trip and that he lost part of his baggage, he returned to the village with a bicycle, a belt "with many pockets",[143] and money with which he courted his first wife and paid for the bride price.

Despite these successful stories, we got the impression that profitable migration is increasingly rare now. During our work in the villages we encountered several young men who had just returned from migration of over one year. They returned with modern life-style goods such as jeans and mountain bicycles to show their peers. However, they seemed to have to sell the bicycles quite soon after their return given their need for cash.[144] The

[143] The monetary value of this belt was substantial but its real worth, according to Piampo, lay in the awe that it evoked from fellow villagers and consequently, its earning him a reputation. The belt was fundamental in giving him the courage to court his first wife who came from a well-to-do family.

[144] The reasons for the difference between the profitability of migration of the two age cohorts remains outside the scope of this study. We can only stipulate that they have to do with the deteriorating economic conditions of

effect of today's kind of migration among Gourmantché men, thus, is that migration remittances in the research area are virtually nil.

In conclusion, in both villages arable farming constitutes an important source of consumption as well as income for men and women and is the main activity by which people define themselves. However, all case studies engaged in a large repertoire of supplementary activities. Farming therefore, is only one aspect, albeit an important one, in a repertoire of activities that people engage in to make their livelihoods. Furthermore, all case study individuals except for women in Pentouangou receive the majority of their receipts from market transactions[145] in which they sell agricultural, livestock, and off-farm products. This confirms our argument that market transactions have become prevalent phenomena in people's everyday lives. However, thus far we have only dealt with a part of the total receipt transactions of the case study individuals. The rest of the picture, social transactions and loans, will be discussed in sections 7.5 and 7.6, respectively. Below, instead, we turn to how people use their receipts.

7.4.3 How do people use their receipts?

The analysis that follows focuses on people's expenditures (tables 7.6 and 7.7) and as such can help shed light on whether this is a subsistence economy in which all efforts go towards subsistence-level consumption. We saw in tables 7.2 and 7.3 that people produce more than they consume. However, they may not be consuming their production because they are forced to sell their harvest due to debts or pressing needs and later need to go into debt again just to obtain basic necessities. In such a case they remain subsistence farmers in which all activities are geared towards ensuring a daily existence. It is therefore important to look at how people use their surplus (i.e., what is obtained above and beyond own agricultural production that is consumed) to gain an understanding of the economy and the constraints, objectives, and values that define what is possible.

Basic necessities

The increasing influence of markets on people's everyday lives means that basic necessities such as food, clothes and medicine, can be purchased by villagers rather than produced by them. We begin by looking at what portion of total expenditures go for covering people's basic necessities to see to what degree people are able to invest in things other than subsistence goods.

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neighboring countries such as Ivory Coast and Ghana and with the fact that life-styles at home are changing. The reasons why these forces do not hamper migration among the Mossi of the Central Plateau as documented by Breusers (1999), for example, most likely relate to a less extensive network of relations in the foreign countries as have the Mossi.

[145] A market transaction is a transaction that involves the buying and selling of products in exchange for money. These transactions do not need to take place in actual market places.

Table 7.6 Expenditures of case study individuals in Samboanli, December 1996 to November 1997

Cmp.[a]	Hh.[b]	Name (relationship[c])	Basic necessity[d] (%)	Livestock (%)	Off-farm (%)	Crop production[e] (%)	Services[f] (%)	Other (%)	Social transactions: Ceremonies (%)	Social transactions: Other gifts (%)	Loans[g] (%)	Total (fcfa)
							Women					
S1	A	Yempousa (wife 1)	48	1	11	0	7	0	22	10	0	58,433
		Folpoa (mother)	88	0	0	0	0	12	0	0	0	9,427
S2	B	Oureta (wife 3)	64	0	0	0	0	24	0	12	0	27,494
S2	C	Dahani (wife 1)	33	16	11	0	0	0	1	26	13	165,798
		Miabala (wife 2)	54	5	0	0	0	0	19	20	0	93,288
		Dapoa (wife 3)	47	0	9	0	0	0	2	34	7	60,497
S3	D	Podiandi (wife 1)	54	0	0	0	4	4	5	33	0	22,817
S3	E	Possi (wife 1)	48	0	0	0	0	0	41	10	0	42,295
		Sacou (wife 2)	38	0	0	0	2	1	39	21	0	47,236
		Mindiba (mother)	1	36	58	0	0	1	0	5	0	22,480
Average per woman			*47*	*6*	*9*	*0*	*1*	*4*	*13*	*17*	*2*	
							Men					
S1	A*	Bandia	15	32	0	0	7	1	36	5	4	569,879
S2	B*	Hambila	6	19	3	1	2	10	19	21	20	1,140,925
S2	C*	Piampo	10	60	0	1	0	2	6	21	0	367,834
S3	D*	Konkoari	25	0	0	2	2	5	53	14	0	55,388
S3	E*	Yabre	29	5	0	2	6	9	26	18	4	154,919
Average per man			*17*	*23*	*1*	*1*	*3*	*5*	*28*	*16*	*6*	

Source: Budget diaries. [a]Compound code; alike numbers indicate members of a single compound. [b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head. [c]Relationship with respect to head of household. Nothing is marked for the household head himself. [d]Includes food (prepared and coarse grains, fresh produce, sauce ingredients), medicine, clothes, household items (soap, utensils), and maintenance items (petrol, batteries, bicycle parts). [e]Includes all investments for crop production such as the purchase of equipment and inputs as well as agricultural services such as tractor plowing. [f]Includes all non-agricultural services such as repairs (bicycle, motorbike, radio, cooking pot), mill grinding, tailoring, transport, hospital fees, education, house construction. [g]Loans the case study individual gave out and loans that he/she repaid.

Table 7.7 Expenditures of case study individuals in Pentouangou, December 1996 to November 1997

Cmp.[a]	Hh.[b]	Name (relationship[c])	Basic necessity[d] (%)	Livestock (%)	Off-farm (%)	Crop production[e] (%)	Services[f] (%)	Other (%)	Social transactions: Ceremonies (%)	Social transactions: Other gifts (%)	Loans[g] (%)	Total (fcfa)
						Women						
P1	A	Taala (wife 1)	91	0	0	0	3	0	4	3	0	22,474
		Aminata (sister in law)	44	0	41	0	0	5	0	0	9	22,444
		Larba (mother)	34	0	36	0	0	6	0	11	13	26,427
P1	B	Aibibatou (wife 1)	49	2	27	2	0	2	0	11	5	123,023
		Tembendi (wife 2)	73	0	0	0	0	13	0	13	1	22,740
P2	C	Kilpoa (wife 1)	40	5	0	0	11	15	0	21	8	28,109
		Potaga (mother)	16	0	0	0	0	57	0	0	27	3,752
P2	D	Kayaba (wife 1)	59	0	0	0	9	2	0	1	30	31,761
P3	E	Lamousa (wife 1)	64	10	18	0	3	2	0	3	0	31,792
		Noro (wife 2)	65	1	12	4	0	0	0	17	0	20,049
		Valga (sister in law)	66	4	0	0	0	0	0	20	10	23,106
Average per woman			*55*	*2*	*12*	*1*	*2*	*9*	*0*	*9*	*9*	
						Men						
P1	A*	Djoulmani	29	5	0	10	9	23	0	14	10	550,452
		Dossi (brother)	32	19	16	6	2	4	0	10	11	199,081
		Laya (father)	17	7	51	0	0	2	0	3	20	138,772
P1	B*	Ahandi	11	1	36	2	0	3	1	4	42	214,743
P2	C*	Noaga	35	0	0	3	0	12	0	10	40	26,635
		Diakiro (father)	37	6	33	0	0	0	0	14	10	60,729
P2	D*	Babrile	66	4	0	2	0	11	0	8	8	30,596
P3	E*	Sambo	50	0	0	0	7	35	0	8	0	147,333
		Marhi (brother)	36	36	0	9	3	3	0	12	0	145,637
Average per man			*35*	*9*	*15*	*4*	*2*	*10*	*0*	*9*	*16*	

Source: Budget diaries.

Notes: See notes to table 7.6.

The column basic necessities in tables 7.6 and 7.7 refers to those things that are purchased to maintain the basic needs of daily life such as: food (prepared and coarse grains, fresh produce), medicine, clothes, household items (soap, utensils), and maintenance items (petrol, batteries, bicycle parts). Recall that this category does not include consumed own production. However, summing the quantities consumed of own production, of food gifts received, and the quantities of purchased food grains, reveals that all households except for two are able to meet their stated dietary needs (table C.5 in appendix C). In the case of Yabre's household, which has a deficit of 34% of its total needs, we suspect that his wives' and mother's incomes could have been used to make ends meet but went unreported, as these people had a budget surplus (this will be shown in section 7.6.1). Babrile's household had a deficit of 26% of their total stated dietary needs which is likely compensated by unreported gifts of food from elderly parents and an older brother with whom he lives in the same compound. All of these people had budget surpluses. These findings, combined with the fact that most people spend less than half of their total expenditures on basic necessities, suggests that most of the case study households are meeting their subsistence needs and engage in expenditures that go beyond these needs.

There are, however, some important differences in spending on basic needs that should be noted. On the whole, women tend to spend much more of their total expenditures on basic necessities than men. Furthermore, case study women in Pentouangou spend a larger percentage of their expenditures on basic necessities than their northern counterparts. As was explained above, women in Pentouangou have entered agriculture at a later stage than women in Samboanli and thus they cultivate less area for themselves. The little production that they have thus goes towards meeting basic needs. Their crop production is relatively low and they do not produce enough surplus with off-farm activities for them to be able to invest in other than basic consumption. This can be seen when we compare the two most well-off women in the northern and southern case studies, Aibibatou and Dahani, whose spending on basic necessities is 49% and 33%, respectively.

Case study men, by contrast, spend a relatively small percentage of their total expenditures on basic necessities. The fact that men spend less on basic necessities than women is a reflection of the customary division of tasks. Men contribute to their household duties by providing for the household's food consumption through own production and women are responsible for providing sauce ingredients, clothes, and medicine for themselves and for their children, and where applicable contribute to education fees. This means that men normally contribute to their household duties through cultivating whereas women do so through the market. This is the general division of labor. There are differences from household to household in the arrangements that exist between husbands and wives. For example, Yabre provides the sauce ingredients (those not grown by the women themselves) for both of his wives which explains why his wives are on the lower spectrum of spending on basic necessities while he is on the higher spectrum for men. In general, however, men in the southern village spend a larger portion of their expenditures on basic necessities because their wives earn less and thus are not able to provide for basic necessities on their own. What explains the largest difference between men in the north and in the south is that in the south those households that grew rice spent a lot on buying millet and sorghum for consumption. Rice has not fully entered the consumption patterns: it is eaten but most people growing rice still prefer to eat tô made from millet and sorghum and therefore sell rice to buy these grains.

Despite the differences between the northern and southern village and between men and women, the fact remains that every case study individual used their receipts for things other than basic necessities and for 23 of the 35, individuals non-subsistence expenditures amounted to more than half of their total expenditures. The question then arises, how do people use the remainder of their receipts?

Livestock

The category labeled livestock in tables 7.6 and 7.7 excludes those cases in which livestock was bought for use in a ceremony. This category thus represents livestock that was bought with no immediate purpose in mind other than as a form of investing one's savings or as an activity with which to make profits.

Resulting from key informant interviews, livestock is one of the most preferred investment options because it serves various functions. It provides a way to keep one's savings in a non-conspicuous way. Not showing one's wealth in an outwardly egalitarian society such as that of the Gourmantché is an important consideration when one has savings. Whether or not it gets used as such, livestock is seen as a safety measure in case of emergencies.[146] Further, it reproduces itself thus augmenting one's savings, and it is perceived as something for which there will always be a buyer and for which the price will never be lower than what was originally paid for the animal.

Livestock, however, does involve some risks. The main one being livestock diseases which have caused the decimation of herds at different points in time in both of the research villages. In the case of cattle rearing, an additional risk is the possibility of an unfaithful cattle herder who steals or sells one's cattle, a frequent complaint that Gourmantché cattle owners have regarding their Fulbe herders. Informants recognized these risks but felt nonetheless that the benefits made the risks worth taking.

Budget data confirm these interviews. All men but the poorest of the northern case studies invested to some degree in livestock. Even Bandia who struggles to make ends meet and needs to receive gifts to provide for his family's consumption needs, invested over 30% of his total expenditures in livestock. The richest man, who invests substantially in different investment options, invested almost 20% of his total expenditures in livestock.

The fact that in Pentouangou men invest less in livestock than in Samboanli is not a reflection of the lesser interest in livestock in the south, but rather of the difference in histories of Fulbe settlement between the two villages. As will be argued in chapter 8, cattle ownership necessitates relationships of trust between Gourmantché and Fulbe and the northern village has had more time and the appropriate social context in which to develop them.

Women's investments in livestock are largely limited by their lower income. Dahani, the richest woman of all the case studies, is the only one to have her own cattle. In 1997 she

[146] Fafchamps *et al.* (1998) conclude that cattle are not sold during widespread famine. However, for the purposes of our argument, it is important to see how cattle is perceived rather than how it gets used in actuality.

owned four cows and was aiming at buying more. In general, case study women owned up to seven goats and sheep in 1997. Those who had none were either young or poor. Most livestock purchases for women were made by their husbands. This is due to the fact that customarily livestock transactions are carried out by men.

Off-farm activities

The category off-farm in tables 7.6 and 7.7 represents those things bought to conduct off-farm activities for which more than one's own production or products gotten from the bush are needed. These can include things such as buying tobacco and kola nuts to resell, purchasing cloth for tailoring, buying goods for petty trade, buying grain to resell later in the season, and buying ingredients for beer brewing. If one compares the receipts and expenditures of off-farm activities, there are certain cases in which the costs of doing off-farm activities far exceed the benefits. This is in part because a portion of what is sold through petty trade is given on credit and therefore partially appears in the column labeled loans in tables 7.6 and 7.7. But even if these are added, some imbalances remain for four people. This is the case for Laya and Larba because they engage in petty trade of tobacco and kola nuts. These are typical goods which the seller uses to give as gifts to friends and family. They are also sold in small quantities so that if bought on credit, they are easily forgotten and never repaid. Finally, they are products that are consumed by the sellers themselves. When Laya was asked why he even bothered to sell kola nuts after we calculated his losses together with him, he replied, "but if I did not sell kola nuts then I would have to buy them from someone to consume them myself!". All of these reasons account for some of the losses incurred. Aminata and Dossi are the other two cases but their greater off-farm costs are explained by the fact that in 1997 they decided to invest heavily in petty trade for the first time so we recorded their costs but not their benefits which may accrue in the following years.

Crop production

Equally revealing are those things for which people do not use their receipts. The two lowest expenditure categories across the board are agricultural investments and paying for services. Agricultural investments that were recorded are buying a hand hoe, parts for a plow, seed, minimal amounts of insecticide to apply to granaries, goods offered at agricultural work parties, and paying for tractor plowing. The people for whom agricultural investments represent a slightly larger portion of total expenditures (between 6% and 10%) are those who cultivate rice in the south because they pay for tractor plowing, which at the time cost 12,000 fcfa for one hour's worth of work. This was the case for Marhi, Dossi, and Djoulmani. It is noteworthy that paid agricultural labor does not appear. This reflects the fact that when a farmer is in need of labor, he or she is more likely to call a work party rather than to hire labor. Such a choice is guided by attitudes surrounding paid labor that will be discussed in chapter 8.

Non-agricultural services

Paying for services is also low. The most frequently paid for services in both villages are equipment repairs. These include bicycle, radio, motorbike, and house repairs. Additionally, in the southern village there were frequent payments for grain grinding at a mill. An electric mill was repaired in a nearby village (Kikideni) during the course of this study. Almost overnight the sounds of mortar and pestle became much less intense in the village even though this meant that women had to carry headloads of grain 2 km to reach the mill. This shows that there is a demand for this kind of service. Other services paid for include transport, tailoring, hospital fees, and education. Education fees are not a large part of people's budget ranging between 1% to 6% of total expenditures for those who had children in school. In the north each one of the households of the case studies had at least one child enrolled in school whereas in the south no expenditures were recorded for education. It is not possible from our sample to say if children are less schooled in the south. But in the north there were several elementary schools located in nearby villages such as Bilanga, Piéla and Bilanga Yanga. In the south, instead, the nearest schools were in Fada N'Gourma and Niendouga (7 km). However, since Fada N'Gourma became provincial capital and home to many state employees, its schools are frequented by children of urban dwellers and may be less accessible (space and social status) to villagers.

Other

Another important indication that people are not only concerned with subsistence expenditures are the luxury items that appear in the budgets of some of the case study individuals. These comprise the category other in tables 7.6 and 7.7. Small items such as kola nuts and tobacco are the luxury expenditures for women and poor men. For men, there are also larger items in this category. Djoulmani, Sambo, Hambila, and Yabre bought a motorbike, a bicycle, two bicycles and a gun, and a radio, respectively.

While two important expenditure categories, social transactions and loans, will be discussed in sections 7.5 and 7.6.2, respectively, certain conclusions can already be drawn. Spending patterns do not follow a strict subsistence pattern but rather show a rich variety of options: basic necessities are bought and not only self-produced, savings are kept as livestock, investments are made in off-farm activities, and luxury items are bought. Furthermore, even though arable farming is a primary income earning activity as well as contributes substantially to meeting subsistence needs, it receives relatively little monetary investment.

7.5 Social transactions

Until now we have focussed on those receipts in which goods are sold for money. This showed the kind of income earning activities people engage in. We have also focussed on expenditures in which people use money in order to buy goods for consumption (basic necessities, luxury goods) or for investment (livestock, crop cultivation, off-farm) or for savings (livestock). We have seen the importance of these transactions in terms of the percentage they comprise of total receipts and expenditures and also in terms of their pervasiveness in all aspects of people's livelihoods. We have also seen that historically trading has been conducted for centuries. All of these are signs of a society that is well integrated in a market economy. It is therefore an important and surprising finding that social transactions[147] are also an important item in people's budgets. In fact, social transactions in Samboanli average 30% and 44% of the total value of expenditures for case study women and men, respectively, and in Pentouangou they average 9% for both men and women.

This result is all the more surprising because of its quantitative nature. Household budget surveys conducted in West Africa have rarely shown social transactions as an important component of household budgets (Ellsworth (1988) is a notable exception). An example is one of the most comprehensive, long-term household budget surveys conducted in West Africa by ICRISAT in Burkina Faso between 1980-85 (Matlon 1988). The survey found that gifts comprised only 3% of the total income of the poorest of Sahelian households whereas the poorest household heads amongst our case studies received between 16% and 53% and their wives between 2% and 36% their total receipts from gifts. Other surveys, such as one conducted in 1978-79 in the eastern region (Barrett *et al.* 1982), focus on cash transactions and omit gifts all together.

We will look at some of the characteristics of social transactions but first a word is in order to explain why the results of this study differ from other quantitative surveys of household budgets. The ICRISAT survey will be used as an example of a survey that made an attempt to quantify social transactions. The ICRISAT survey and the budget diaries of this study were conducted in different parts of the country with different ethnicities which may explain some of the observed differences. However, the ICRISAT survey extended across three agro-ecological zones and included various ethnicities. It therefore seems highly unlikely that Gourmantché are a unique case of gift-giving people. It is all the more unlikely given the reputation that Gourmantché have in the rest of the country for being individualists.

The difference in survey results then comes down to research methods. Gifts can be a sensitive item for respondents to talk about. During this study we noticed an underreporting of gifts of grain received due to the feelings of shame these evoke in the recipient. We only were able to notice this underreporting because three of the case study individuals reported giving gifts of grain to another of the case study individuals but the latter person never reported them. Furthermore, the data and our observations make us suspect that gifts of money from elderly women to men in their household do not get reported. Finally, by conducting individual interviews with case study individuals it was found that women were underreporting the gifts they made to their natal family for fear of seeming to be boasting. Once the women trusted that the results would not be made public in a way that could be traced back to them they began to declare these gifts in the budgets. The sensitivity of certain gift transactions can only be addressed by building trust between enumerators and

[147] Social transactions include two categories: (1) all in-cash and in-kind gifts given for ceremonies and any costs incurred associated with these ceremonies, and (2) all in-cash and in-kind gifts given or received outside the realm of ceremonies.

respondents. This is much more easily done with a small-scale, case study approach than with a large number of people involved in large-scale surveys (chapter 1).

Household budget surveys such as the one by ICRISAT, primarily obtain budget information from the household head. This most likely produces a great underestimation of gifts that women give and receive as our experience showed that men were not aware of the detail of their wives' social transactions. Ellsworth (1988) who paid particular attention to social transactions but who conducted interviews primarily with household heads also notes this as a source of flaw.

Social transactions can also easily lead to enumeration problems as they can be a quite fuzzy category at times. A goat bought and later in the year given at a funeral may be recorded as an item bought and not associated with the ceremonial transaction that subsequently takes place. Such cases were found to be frequent because respondents were more prone to declaring the purchase and not the actual act of sacrificing the goat at the funeral. Also, what one person considers buying to give a gift, another may consider buying to fulfill an obligation. Gifts thus give rise to enumeration errors, have interpretation problems and require more time. We found that it was necessary to go back and conduct interviews with each of our respondents to get a better understanding of the gifts they made and received. Again, this is only possible if the number of respondents is limited.

Finally, an important difference between the ICRISAT survey and the budget diaries is that they were conducted at different times. The ICRISAT survey took place during and after one of the worst Sahelian droughts in recent history. People had very few resources left to give as gifts and because the calamity was geographically widespread, even people's wider networks did not help. The data for the budget diaries were collected during an average year. Thus if the ICRISAT survey was able to overcome the problems inherent to large-scale surveys, it may show that gifts cannot provide livelihood security in times of large-scale catastrophes. The budget diary data, on the other hand, show that in average years, people do consider it important to invest in relationships through gift giving and ceremonial expenditures. How they use these relationships is the subject of chapter 8.

We now turn to some of the characteristics of social transactions by looking at their role first in total inflows and then in total expenditures. Two important points will be made. The first is that social transactions are an important part of people's livelihood decisions and the second is that these transactions are more important in the northern village than in the southern village.

In general, gifts received comprise a large part of people's receipts if they are poor but well connected in a network of people whose resources they can tap in times of need. This is the case for Bandia, Konkoari, Babrile, and Noaga who, in 1997, were amongst the poorer heads of households from the case studies and received between 27% and 53% of their total receipts from gifts (see tables 7.4 and 7.5). Both Babrile and Noaga live in the same compound. They come from one of the founding families of the southern village and are thus connected by kinship to other villagers. Bandia has kinship ties with Hambila and Piampo, both of whom are members of one of the richest families in the northern village and part of the descent group of the chief of Bilanga. Sambo instead is also a poor head of household but receives only about 16% of his total receipts from gifts. He is young and heads a young household composed of his two wives, and his brother with his wife.

Together they have three children below the age of five. They once lived in a large compound which subsequently split up. A series of deaths, of which their father's who died around 1987, left the two young brothers alone in their compound. They have a relatively small network of people whom they can rely on for gifts.

But social transactions are not only important for the most needy. Rich and poor alike engage in social transactions (Ellsworth (1988) makes a similar point for two villages in western Burkina Faso). Hambila, the richest man in the north, spent about 40% of his expenditures on social transactions while Bandia and Konkoari, both of whom needed to buy or receive gifts of grain to feed their families in 1997, spent 41% and 68%, respectively. In the south Djoulmani (with his brother Dossi), one of the well-off case studies and Sambo (with his brother Marhi) who is struggling to make ends meet, gave 24% and 20% of their total expenditures, respectively, in gifts. This indicates that while rich and poor may engage in social transactions for different reasons, they both see these transactions as an important part of establishing their livelihoods.

This points to the striking characteristic of social transactions: they are the transactions in which the largest number of people engaged in after selling of crop production and buying of basic necessities. This indicates the pervasiveness and importance of social transactions.

Figure 7.2 shows the types of products used in expenditures for social transactions. The information is presented for Samboanli because the quantity of social transactions recorded was greater in that village and therefore can offer a more complete picture. Money is the most frequent and highest value item in social expenditures. This points to the fact that money is used for both market and social transactions. Furthermore, half of all money used for social expenditures was used at or for ceremonies. This includes, for example, money that was given as gift to a bride's family and payments made to singers and dancers at funerals. The extent to which money is used in ceremonies has increased in the last half

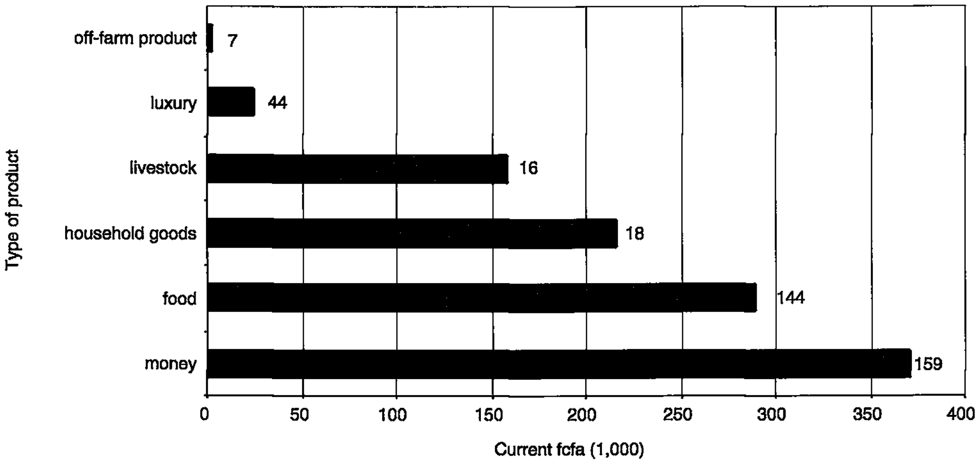


Figure 7.2. Expenditure for social transactions, Samboanli, December 1996 to November 1997
Source: Budget diaries.
Note: Numbers at the end of bars indicate the total number of transactions recorded in that category.

century and is a case of a "traditional" institution adapting to the increasing pervasiveness of market transactions. The case of bride price is illustrative. Half a century ago bride price was paid in cloth, labor, livestock, and bundles of wood. Money or cowries were not part of the bride price. Today bundles of wood are no longer brought to the bride's mother and the quantities of cloth have decreased. However, every groom pays an amount of money on which the bride's family agrees to settle the marriage. The amount of money to be paid is not a fixed amount, but depends on the wealth of the groom and the social standing of the bride's family. However, to our knowledge, it is not possible to marry today without also paying money.

The timing of a gift can be of crucial importance. Right after a harvest, gifts of grain, groundnuts or any other crop produced, are given as tokens of appreciation for services rendered or merely as symbolical acknowledgements of the relationship existing between the giver and the receiver. Ceremonies are also largely celebrated after the harvest, when people have returned to the village from their bush camps. Figure 7.3 shows the distribution throughout the year of gifts of money and food given for non-ceremonial purposes and compares these with the buying of grains for Samboanli.[148] We see that in an average harvest year such as 1996, gifts of food are just as important a means to obtain food as buying grain. Furthermore, in the last period, when people are most in need of food because stocks are running out and the new harvest is not yet in, gifts of grain and of money are more important than grain purchases. This indicates that gifts of money and food are important means with which production is redistributed amongst the population in times of localized production fluctuations.

Social transactions point to an important difference between the northern village and the southern village: they are more frequent and larger in value in the north than in the south. This shall become more apparent when we look at gifts given below. Various factors obscure this finding when we look at gifts received (see tables 7.4 and 7.5). Gifts received by villagers in the south are made to seem larger by the fact that Pentouangou is closer to state health services and provincial political headquarters (based in Fada N'Gourma). State health care services give women gifts of food for their infants (salt, sugar, oil, cowpeas and millet) when they bring them for their routine check-ups. Various southern case study women received these gifts. In 1997, political parties were holding rallies in villages close to Fada N'Gourma and giving gifts of oil, sorghum, and cans of sardines and corned beef to those men who attended. If these kinds of gifts are not included in the receipts data, then the overall importance of gifts received for women declines minimally but for men it declines from 15% to 13%, substantially lower than the 19% of the northern men.

For southern women, gifts received are an important source of receipts. A large part of the gifts received by women in the south consist of husbands buying clothes for their wives. This reflects the fact that women's incomes are lower in the south, making it more

[148] Gifts of money and food given are used for the comparison, rather than gifts of money and food received. This is because the data are more complete for gift giving than for gift receiving since, as was explained at the beginning of this section, the shame that gifts of food and money can evoke on the receiver may cause underreporting. Also, the data are presented for Samboanli because, as will be pointed out later in this section, gifts are more prevalent in Samboanli and thus comprise a greater number of observations.

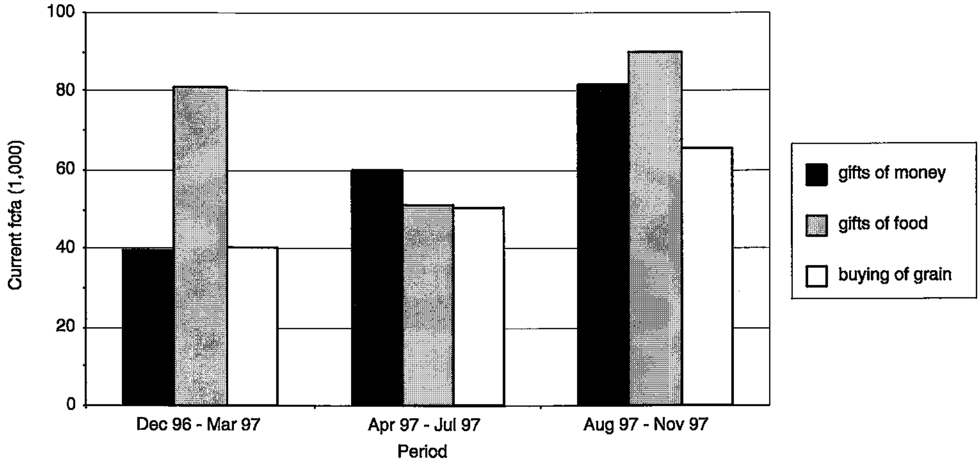


Figure 7.3. Gift giving and grain purchases, Samboanli, December 1996 to November 1997
Source: Budget diaries.

difficult for them to buy their own necessities. Furthermore, in the three cases where men grew rice, their wives cultivated almost exclusively on their husband's fields and were "rewarded" at harvest time with what the women termed as a "gift" of rice for them to sell and buy what they wished. In the north women bought their own clothes and, having their own fields, they are not given "gifts" of thanks for their labor on their husband's field. Southern women also receive gifts from their natal families. This will be analyzed more in detail in chapter 8. All of these factors contribute to making gifts account for one third of southern women's total receipts.

The expenditure data instead make the differences between the two villages very clear: spending on ceremonies and on gifts are much higher for both men and women in the northern village (see tables 7.6 and 7.7). In the southern village spending on ceremonies is virtually nil. For women, this result may also be due to the fact that there are proportionately more women in the southern case studies who are in an early stage of their life cycle when funerals do not abound. However, even among the southern men who are comparable in life cycle to their northern counterparts, ceremonial spending is virtually nil. Furthermore, gift giving outside of ceremonies in Samboanli is almost double that in Pentouangou.

These figures confirm the observation made in chapter 4 that traditions in Samboanli seem to occupy a greater portion of daily life than in Pentouangou. For example, there are more ceremonies in the north, such as Fanfama in which the ancestors are thanked for the harvest. While this happens every good harvest year in the north, a similar thanking celebration happens less often in the south. The chief of Pentouangou explained this phenomenon by saying that ceremonies to thank ancestors must be decided upon in meetings with all compound heads of the village. The young compound heads that have emerged with the more frequent splitting of compounds (chapter 4), give less importance to these ceremonies and therefore do not vote for them every year. Also the pooling together of money for common expenditures within groups defined by kinship, religion, or activity was encountered more frequently in the north than in the south (further discussed in chapter 8). Additionally, the north is renowned for having powerful magic (*wack*) and evening conversations are full of hearsay recounting what happened to an individual who encountered, conducted, or was subject of magic whereas in Pentouangou this was much less so. Giving children to other kin relations to raise seems to be actively practiced in the village in the north while in the south it was mentioned as something that is hardly done anymore. Finally, bride price in both villages involves payments of money as well as cloth, labor and livestock but in the north there are other gifts that the groom needs to make which in the south are not made. An example is the goat that the groom-to-be must give during all the years of his courtship to his fiancé's family during the yearly Fanfama ceremony. Also, the village survey indicates that work parties called by the groom-to-be are less frequent in Pentouangou than in Samboanli.

The greater role of social transactions in the northern village is an important and somewhat surprising finding because it occurs precisely in the village where markets and trade have been historically more active, where women produce and market greater quantities of their own production, and where the flows of cash going through people's hands seem to be greater. This highlights that categorizing economies in a binary fashion in which traditional and market economies are mutually exclusive categories, does not do justice to the dynamics of how an economy develops.

Three important findings should be noted by way of summary to this section: (1) social transactions are important even where market transactions are part of everyday life, 2) they occupy an important part of people's budgets and as such are important in livelihood decisions, and (3) differences between Pentouangou and Samboanli show that social transactions can develop in different ways depending on the local historical context.

7.6 Money and its morality

The mixing of social and market principles means that economic decisions will be the outcome of a juggling of these principles. As Guyer explains, "people themselves can rarely afford to entertain an opposition between culture and rationality (in the conventional economic sense of cost-benefit calculation). They try to keep and eye on prices at the same time as an ear to the voice of the gods, and they struggle to make short-run responsiveness a meaningful phase in a long-run career." (Guyer 1997: 13) Below, we look at how economic action and concepts are influenced by this mixture of principles.

7.6.1 Savings and "hooking your money onto something"

When we look at people's budget balances (balance = receipts – expenditures) in tables 7.8 and 7.9, we note that there were both men and women that had surpluses or deficits amounting to well over 30% of their total inflows. Given the categories of our budget survey, the only aspects that were not included and can help explain the imbalances, are gifts given of own production (including crop and livestock) and monetary assets because both categories appear only as an expenditure and not as a receipt. However, when looked at in greater detail, we see that some of these deficits and surpluses can be explained "away". Once certain large surpluses are explained, it will become evident that the majority of case study individuals had expenditures that were close to their receipts.

Women's large surpluses that can be attributed to monetary assets are those of Dahani and Oureta. Dahani keeps her money with her husband and as soon as she has enough saved, will spend it on buying cattle. Other surpluses held by women tend to be those of the elderly or wives of poor household heads. As they help the household heads in times of need, there is reason to suspect that these surpluses are actually unreported gift giving to the household head. These may be considered by the people involved as obligations a wife or mother has to her household and therefore may not be reported as a gift by either husband/son or wife/mother. Women who fit in this category are Folpoa, Podiandi, Possi, Mindiba, Potaga and Kilpoa. Furthermore, we learned of women's reticence to report the gifts they make to their natal families. This most likely explains the surpluses held by Noro and Tembendi, both of whom spent extended periods with their natal families in 1997.

Men with surpluses are few and can be largely explained by other than monetary assets. Marhi gives the money he earns from rice cultivation to his older brother and household head, Sambo. This thus also explains Sambo's large deficit. Djoulmani spent his surplus just after the end of the budget year on setting up a stand at the Fada N'Gourma daily market. We know he spent over 100,000 fcfa and that the following harvest was only

Table 7.8 Budget balance for case study individuals in Samboanli, December 1996 to November 1997

Cmp.[a]	Hh.[b]	Name (relationship[c])	Total receipts (current fcfa)	Total expenditures (current fcfa)	Budget balance (current fcfa)	Budget balance as % of total receipts (%)
			Women			
S1	A	Yempousa (wife 1)	55,424	58,433	-3,009	-5
		Folpoa (mother)	41,757	9,427	32,331	77
S2	B	Oureta (wife 3)	51,760	27,494	24,266	47
S2	C	Dahani (wife 1)	297,660	165,798	131,861	44
		Miabala (wife 2)	92,052	93,288	-1,236	-1
		Dapoa (wife 3)	68,982	60,497	8,485	12
S3	D	Podiandi (wife 1)	35,124	22,817	12,307	35
S3	E	Possi (wife 1)	77,317	42,295	35,022	45
		Sacou (wife 2)	51,947	47,236	4,711	9
		Mindiba (mother)	59,384	22,480	36,904	62
			Men			
S1	A*	Bandia	177,577	569,879	-392,302	-221
S2	B*	Hambila	851,719	1,140,925	-289,206	-34
S2	C*	Piampo	250,858	367,834	-116,976	-47
S3	D*	Konkoari	30,107	55,388	-25,281	-84
S3	E*	Yabre	93,005	154,919	-61,914	-67

Source: Budget diaries.

[a]Compound code; alike numbers indicate members of a single compound.

[b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head.

[c]Relationship with respect to head of household. Nothing is marked for the household head himself.

a little over half of what he had gotten in 1996 so that he must have used his savings from the previous year.

The remaining budget imbalances to be explained are the deficit spending of the five northern men. They all spent large sums of money on ceremonies. For Bandia 1997 was an exceptional year because his father died. He thus paid for his father's burial ceremony and four months later for his funeral. In 1997 Bandia did not conduct any of his usual grain commerce activities and used all his savings from that activity to pay for these two ceremonies. He kept his money with a shopkeeper in Pouytenga. We have also noted that deficit spending may appear as a result of an underreporting of gifts. Above we mentioned women's underreporting of gifts they give to their husbands and sons. There is also the embarrassment attached to receiving gifts of grain which make them be underreported. Bandia is again an example. We know that gifts of grain to him appeared in Dahani's, Piampo's, and Yabre's budgets which he never declared to have received. Finally, as was

Table 7.9 Budget balance for case study individuals in Pentouangou, December 1996 to November 1997

Cmp.[a]	Hh.[b]	Name (relationship[c])	Total receipts (current fcfa)	Total expenditure (current fcfa)	Budget balance (current fcfa)	Budget balance as % of total receipts (%)
				Women		
P1	A	Taala (wife 1)	33,329	22,474	10,855	33
		Aminata (sister in law)	23,318	22,444	873	4
		Larba (mother)	30,061	26,427	3,634	12
P1	B	Aibibatou (wife 1)	123,852	123,023	829	1
		Tembendi (wife 2)	37,377	22,740	14,637	39
P2	C	Kilpoa (wife 1)	34,753	28,109	6,644	19
		Potaga (mother)	10,955	3,752	7,203	66
P2	D	Kayaba (wife 1)	25,016	31,761	-6,745	-27
P3	E	Lamousa (wife 1)	29,581	31,792	-2,210	-7
		Noro (wife 2)	36,476	20,049	16,427	45
		Valga (sister in law)	28,437	23,106	5,331	19
				Men		
P1	A*	Djoulmani	639,112	550,452	88,660	14
		Dossi (brother)	232,629	199,081	33,549	14
		Laya (father)	166,750	138,772	27,978	17
P1	B*	Ahandi	305,635	214,743	90,892	30
P2	C*	Noaga	34,552	26,635	7,916	23
		Diakiro (father)	116,982	60,729	56,253	48
P2	D*	Babrile	20,067	30,596	-10,529	-52
P3	E*	Sambo	32,237	147,333	-115,096	-357
		Marhi (brother)	231,225	145,637	85,588	37

Source: Budget diaries.

[a]Compound code; alike numbers indicate members of a single compound.

[b]Household code; alike letters indicate members of a single household and asterisk (*) indicates the household head.

[c]Relationship with respect to head of household. Nothing is marked for the household head himself.

noted above, deficit spending may appear due to gifts given of own production, which are only recorded as expenditures and not as receipts. Over half of Hambila's deficit can be explained by gifts he made of his own production. Furthermore, Hambila, Piampo, Konkoari, Yabre and Miabala all made gifts of the livestock they own, which also explain some of the deficits.

Thus we conclude from looking at the budget balances in detail that a few people have monetary savings kept with a trusted someone until the time is ripe to make a large investment, usually cattle or ceremonial payment. The remaining budget imbalances can be explained in terms of unreported gifts given by wives and mothers to their husbands and sons and those given by women to their natal families. Furthermore, own crop production that is given as gifts or loans, as well as owned livestock that is given as a gift or sacrificed, can account for some deficits because they appear only as an expenditure. With these explanations, most of the imbalances are explained "away". On the whole, thus, people tend to live close to their short-term inflows: there was relatively little cash that did not get spent for one purpose or another. People tend to sell goods with a specific expenditure in mind and if they find they have some extra money, as explained by Ahandi, they try to "hook it onto something".

Hooking money onto something has to do with attitudes surrounding money. Unlike a cow, money is divisible into small quantities. It is also not associated with the vital necessities of life as is, instead, millet. Both of these characteristics makes money be perceived as something easy to ask for in loan. In fact, the likelihood with which money is asked for by fellow kin and villagers and the social pressure that there is not to refuse giving a loan, gives people with money but little choice than to lend the money out that they have. Furthermore, loans are not always paid back, and reimbursements are difficult to obtain in times of one's own needs for money. The best strategy then, is to hook money onto something.

There are various ways to hook one's money and investing in off-farm activities is one of them. We came to this concept when talking about why Ahandi engaged in grain buying and selling. His explanation centered on the fact that if you keep money in monetary form and people know you have it, they will ask you for it. But if you buy grain with it, people are less inclined to ask you for it because they know they are asking for something that you could use for the consumption of your household.

The importance of egalitarian principles makes it also important to hide one's wealth. This is one of the reasons that makes investing in livestock so attractive. Livestock can be bought and sold in a non-visible way. Men may commission a trusted Fulbe to sell or buy a cow and will give or receive the money without having to set foot in a market. Furthermore, the Fulbe keeps it with him in the herd he cares for so that it is unclear to an outsider to whom the cattle belongs. Relationships of trust between the Gourmantché cattle owner and the Fulbe herder are such that the Fulbe will not tell other Gourmantché to whom the cattle belongs (chapter 8).

Finally, for those assets held in monetary terms, a money holder is sought who can be trusted to have the money available for you when you need it. Men who had money holders keep their money for them, usually found a business partner who was not located in the village in order to avoid the social pressure to lend money. The only case study woman whom we know had monetary assets, had her husband keep her money. This may be a situation arising from the fact that women's networks are more limited to kin relations than are those of men, due to the fact that they are more bound to the compound to fulfill household tasks. This means that women have little way of keeping their monetary assets free from kin obligations.

The concept of hooking money onto something is a perfect example of the balance that people are constantly juggling between social and market principles. People engage in social transactions but at the same time they hook their money in order to earn profits, save, and invest.

7.6.2 Loans without interest

Loans also reflect the mixture of social and market principles. Loans existed in Gourmantché society for as far back as respondents could remember. In the past, they typically consisted of such things as millet and household goods. Trust was a fundamental characteristic of loans because there were no strict enforcement mechanisms for regulating the repayment of loans. They were expected to be paid back, there was no obligation of repaying the loan in greater quantities than what was loaned out, and there was even social pressure to forget a loan not repaid if it was given to a kin relation. Unpaid loans were not a large source of disputes as can be seen by the lack of court cases on this issue (for example in DOS.TBX. 13-14; DOS.TBX.15-16; DOS.PAL.50-52) as well as through interviews with the chief of the southern village who claimed to never have had to settle a dispute on such a case.

Today the same rules apply to loans as in the past but money has become the primary object of loans. Amongst the southern case study men, monetary loans comprised about 50% of total loans given in 1996-97. The other 50% was composed of a mixture of household goods, livestock, agricultural production, and off-farm products. Despite the alternative uses of money that market opportunities offer a lender, charging interest has not entered the practice of loan giving. Loans are expected to be repaid in exactly the same amount no matter how much time has elapsed. And to the contrary, the more time elapses, the less attention seems to be given to repaying the loan at all. Loans can be repaid in amounts greater than what was loaned but often it is up to the borrower to decide if and how much is given as a token of appreciation rather than as a pre-determined amount.

The fact that market transactions are so widespread today as opposed to half a century ago has affected in-kind loans: they are less easily given than in the past. A respondent explained that fifty years ago, one could obtain food loans with great ease. Even if a person did not work hard cultivating his own field, he could always find someone to lend him some food. Often these loans were more like gifts as they were not paid back. This was due to the fact that a lender had very little to do with excess production besides giving it away or lending it. Now, any excess production can be sold and transformed into money and invested in savings such as livestock. This means that people are a lot more selective in how they give out loans. For example, if a person was judged not to have worked hard during the rainy season and asks for a loan, today he may be refused.

Loans may never be paid back, they account for some of the losses in off-farm activities (see section 7.4.3), and they do not bring any extra money to the lender through interest payments. Why then, despite these losses, do loans continue to play a significant role in people's budgets in the southern village? Do people give loans just out of benevolence or due to social pressure on them to do so? The answer lies in the use of money to give loans and the attitudes that surround money.

Monetary loans are particularly suited for establishing non-kin relationships. This is because money is not associated with basic necessities making monetary loans both easy to ask for (see section 7.6.1) and easy to give. Furthermore, money nowadays can buy almost any necessity in nearby markets, making it useful to any person. Thus, there are always people in need of monetary loans and people able to lend money. Small monetary loans are an optimal way of establishing relationships of trust. As a respondent explained, "you begin by lending someone a little bit of monetary and if they give it back, the next time you can offer them a bigger loan. Slowly in this way you build a friendship."

Villagers in both villages agree that they are more in contact with people from different ethnicities than their parents were. This is largely attributable to greater security (fewer wars, no forced labor, roads giving easy access, etc.) in moving about since a half century, greater frequency of market visits in which they come into contact with more people, and in the south, recent settling in the area by migrants from the north and north west of the country. Monetary loans thus have become a way to extend relationships of trust outside of one's kin.

There are some important differences between the case studies in the two villages. In contrast to gifts, loans are more important in the south. For the southern case study women, loan receipts and expenditures come almost entirely from loans given and repaid to them in their petty trade activities. Since the case study women in the north are less engaged in petty trade, loan receipts and expenditures are virtually negligible in their budgets.

For men the difference between villages is greater. In the north, loans are given to help kin relations in need, or are part of commerce, i.e., people buying and selling things on credit. In the south loans are given for these same reasons but there is another component which comprises virtually half of all loan transactions, that is, lending relatively large sums of money to people interest free. This may be showing a tendency for loans to be replacing gifts in the south as would be foreseen by theories that associate greater market integration with a dwindling of social institutions. However, an interesting characteristic is that loans are always given interest free.

Figure 7.4 shows that about 45% of the total value of monetary loans given by case study men in Pentouangou was given to non kin-relations. Furthermore, we note that about half of the loans made to non-kin relations were made during the most needy period, making them all the more valuable for the recipients of the loans. As we will see in chapter 8, the function of these loans for the lender is not one of monetary profit but of establishing relationships of trust between Gourmantché and Fulbe.

The use of money (and indirectly the greater presence of markets in villagers' everyday lives) has had a two-fold effect on loans: on the one hand it has reinforced the importance of social networking because in-kind loans are not as easily given as a century

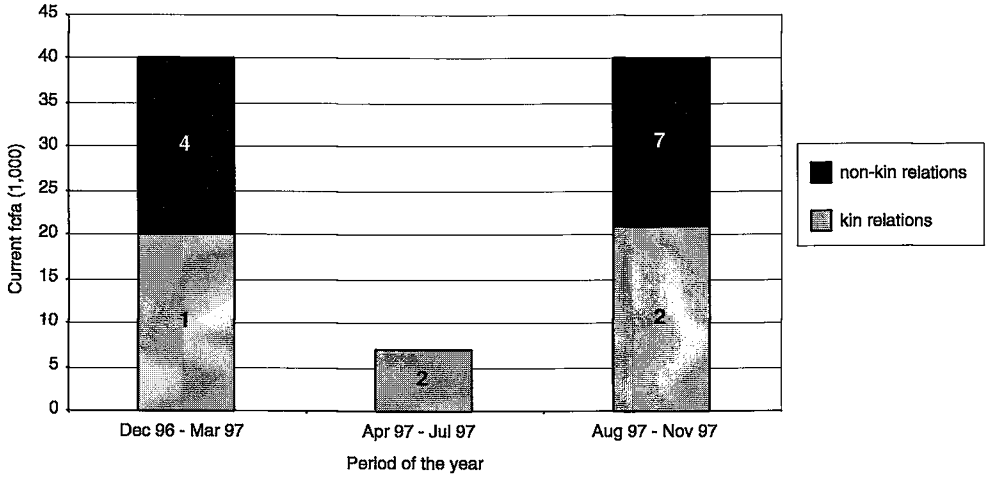


Figure 7.4. Monetary loans given by men in Pentouangou, December 1996 to November 1997
Source: Budget diaries.
Note: Numbers inside bars indicate the total number of transactions recorded in that category.

ago, and on the other hand it has become a way through which to widen the scope of social networks to reach beyond kin relations.

7.6.3 Life cycles, where money comes from, and the timing of investments

Another way that social and market considerations are juggled, is in the timing of investments. Life cycles and where money comes from are two important aspects affecting when people can and will invest. The reason for not investing in certain types of technologies may lie in the inappropriateness of a technology in a local context. But why is it, for example, that people who own cattle, and therefore potentially have the money, will not buy a cart? A cart seems to be appropriate in the local context. It was often at the top of people's wish lists and those who have carts are able to put them to multiple uses, such as transport, selling water, collecting firewood or dung, and construction, through which they earn money. Looking at people's life cycle helps answer such a question. At different times in one's life there are moments in which there are few social obligations allowing one to work hard to produce surplus, other moments in which child rearing takes up a large part of one's labor, and yet other times when social obligations are great. These moments depend on one's age and where one is situated in the genealogical tree of one's natal family.

In comparing key moments when large investments were made (such as the purchase of a plow, cart, or cattle) in the life histories of the case study individuals, we note that the phasing of different cycles in people's lives was important in determining whether surpluses could be produced and how they could be invested. On the one hand there is the cycle of the nuclear family: first a couple has no children to care for; then they have young infants who take much of the mother's time out of production; then a husband may court and marry a second wife which takes up material and labor resources; then young children need to be fed but are too young to contribute to production; when the children grow older, they provide a significant aid to production; then children grow old enough to no longer cultivate on the family field either due to migration or marriage; and finally the couple gets old and is taken care of by the children. These phases happen at the same time that phases occur with the husband's and wives' natal families: first their parents are strong enough to cultivate leaving the husband and his wives (if already married) time to cultivate for themselves; then the parents get old and have to be fed by the couple without contributing much to production; then they die, creating social costs for the husband and his wives for their burial and funeral. The husband may at this point become a head of a household or compound and take on political roles in the community requiring other social obligations. How these phases interweave determine whether the husband and his wives are able to make investments in equipment and cattle or whether all excess production goes for social obligations.

Where people stand in the genealogical tree of their natal families determines how these phases interweave and the amount of responsibility they have in ceremonial contributions. For example, older siblings will be further along with creating their own families when their father or mother die, and they will also be under the largest obligations to contribute to the burial and funeral ceremonies of their parents. In the above example parents of the couple were used, but this same example could be made with the whole range of important members of one's extended family such as maternal and paternal aunts, uncles, grandmothers, and grandfathers. Burial and funeral ceremonies were given in the example above because these tend to be the most expensive ceremonies. The overlapping, sequence and timing of these phases create patches of periods throughout one's lifetime ranging from one year to as much as ten years, in which one is able to invest surplus accumulation in things such as equipment or cattle that require large money outlays. Although the inner workings of these relationships and the obligations that they entail was not the central focus of this study, our findings concur with both Lewis (1981) and Guyer (1972) who studied life cycles in two different West African societies. Both of these studies conclude that life cycles are of central importance in determining production and investment patterns.

Not only do these social events need to coincide at the right time, but so do erratic and unforeseeable events such as rainfall and ill-health. If a period in the life cycle in which surplus accumulation can take place occurs during a dry spell, the period can pass without having accumulated any surplus. Similarly, if a household member falls seriously ill at one of these moments, curing the person may deplete one's savings and diminish the labor available with which to produce the surplus. The arrival of modern medicine and health facilities within the last 50 years may have contributed to raising life expectancy, but it has also considerably augmented the sudden cash needs that illness entails. During the budget year, one of the case study households (P2C) in Pentouangou had two children around the ages of 7 and 10 fall seriously ill. The head of household is poor and did not have any money to pay for their medication. His elderly father contributed about 15% of his total yearly receipts in order to pay for the medication costs. Likewise, in the north, Yabre who is a household head paid a total of 25% of his yearly receipts to cure several bouts of malaria with modern medicine.

Until now we have focused on the life cycle which represents a year-to-year variability that affects the timing of investments. There is also a within-year variability that determines when investments can be made. Ceremonies are generally celebrated soon after the harvest. However, there are some unforeseeable expenses that can occur later in the season which make it unwise to sell all one's production too early after the harvest. Illness during the dry season may mean not being able to engage in off-farm activities and during the rainy season it can take a family member out of production. Both of these affect one's receipts. Selling one's surplus production too early in the season can result in not having the necessary buffer to cover emergencies such as illness later in the year.

There are also risks of diminishing one's social network if investments are made too early in the year. As a respondent explained, if you are in need and you have tried your best to cultivate, people will help you. But if you have just spent a large sum on yourself, people will be more reluctant to help out, thinking that you could have foregone making the investment.

The general selling pattern thus for those who can, is to sell non-food crops just after the harvest to satisfy any pressing needs. Grain crops instead will be sold around June, when the next harvest is close enough in sight to be able to estimate more or less how much grain can be sold. At this point, as basic necessities have been met with income from the non-food crops, the money from these sales goes for making the large investments. Of course, if one has extra groundnuts once necessities are met, groundnuts can also be used to make larger investments. This helps explain the fact that people think of money in terms of its provenance so there is "millet and sorghum money" and "groundnut money". What makes them distinguishable from one another is when they are obtained and the purposes for which they can be used.

What is surprising about this finding is that for people who cultivate millet, sorghum and/or groundnuts, as was the case for most of the case study individuals, the cash crop, groundnuts, was used primarily to meet basic needs just after the harvest, whereas the food crops, millet and sorghum, were used to make the large investments. Normally cash crops are considered as those that allow people to make large investments. This finding thus requires a reconceptualization of the purposes of food and cash crops in the local cultural economy.

In conclusion, the mixing of social and market considerations make the decision of whether and when to invest one's money inseparable from social considerations. These latter are inextricably linked with life cycle, social networks, unforeseeable events, and where money comes from. This has a strong implication for "planning": given the sheer quantity of variables that need to be juggled and their unforeseeability, the most useful plans are those that maintain a high degree of flexibility.

7.6.4 The elusiveness of wealth

What makes a person wealthy is also a mix of social and market principles. Wealth is a combination of the number of people one has in a household, the stage of a one's life cycle, the extent of one's social network (which include also aspects of political power), and the material possessions one owns. All of these aspects are variable, making the categorization of people as rich, average, or poor a highly elusive exercise. Furthermore, the variety of factors that influence wealth makes it difficult to categorize people because, while they may be rich according to one aspect, they may be poor according to another. They may also be temporarily rich while considered to be generally poor. Some examples from our case study individuals can help illustrate the matter.

Typically, material possessions are used as an indicator of wealth in household surveys such as income, livestock, tin roofs, motorbikes, radios, and the like. By this standard, Bandia is rich. He was able to accrue possessions in a stage in his life cycle when he was just married, had few dependents, and had parents young enough to cultivate for themselves. He therefore has a motorbike, two bicycles, a radio, some livestock including at least nine cattle, a plow and three donkeys as traction animals. More recently Bandia had to care for his elderly parents, had young children who were not yet agriculturally active, and was paying for education fees for his brother's son. He was in a situation in which he disposed of little labor for agricultural production, had little time for off-farm activities, and had many obligations. One would then be inclined to treat him as poor. Yet in 1996-97 his receipts and expenditures were relatively high which are uncharacteristic of a poor person's spending pattern. He was however overspending, a lot of which was possible through monetary savings and undeclared gifts (see section 7.6.1). This points to yet another aspect: Bandia is a well-connected man. He is kin to two of the founding families of the village and thus has a large network. In sum, Bandia was rich, is poor, but gets by due to his social network.

The same elusiveness exists for other case studies. Sambo was quite well-off in 1996-97 because he was able to earn well through the rice that his brother cultivated. However, he had just come from turbulent years (as we will see below) and, given his family, has a small social network. Sambo was thus poor, although in 1997 he was able to purchase a bicycle and a donkey and already owned a plow. Noaga's father owns at least six cattle which is a lot for Pentouangou. This would indicate that Noaga should be relatively well-off. However, he is quite poor in that he engages in few activities outside of crop production, consumes virtually all that he produces, and receives little help with cultivation from his blind, elderly parents. Furthermore, he seems to have a restricted social network as was demonstrated when both his sons became ill during the course of this study and the difficulty he had in getting help. His wife helps him with making ends meet. Piampo, despite the fact that he has a large amount of young children to feed, also has three hard-working wives who help cultivate his fields. One wife even owns a donkey and plow which he uses on his fields. Piampo is considered by villagers to be a rich man.

For women, wealth depends on having surplus production but also on having a "good" husband who will help or even allow them to invest. The wealth rankings revealed this fact. When women were asked "what makes a woman well-off?", they replied a "good" husband. What makes a husband "good"? One who helps his wife invest in livestock. The importance of the relationship between husband and wife for a wife's ability to invest can be seen through Dahani's example. When Dahani wanted to buy a plow, quite an exceptional expense for a woman, she first needed to ask her husband permission. After concluding that it was a good idea, the husband went to the compound head to convince him to allow the investment to take place. Note that Dahani's husband keeps her money for her and had he been contrary to the idea, she would have had little choice.

It is also easier for women to accrue wealth if they have a co-wife with whom they get along. Co-wives split household tasks and therefore have more time to cultivate their own fields. They also split the costs of any purchased meal ingredients. However, as Dahani who has two co-wives explained, if there is a scarce resource such as manure, it will first go to the husband, and what is left over needs to be divided among the wives. Thus the more the wives, the smaller the portions of a scarce resource.

Being part of a household in which the household head is able to cultivate enough to feed the family, can allow a woman to use her own inflows to make investments rather than having to help her husband, but whether this is so depends on the division of tasks that exists between husband and wives. There is a customary division of tasks, but the arrangement in practice can differ from household to household. Even within the small sample of case study individuals there were women who had to buy their own sauce ingredients such as Piampo's wives, and women whose husband instead would buy the ingredients for them, such as Yabre's wives. This made up a large part of the differences between women's spending on basic necessities. Furthermore, Oureta, the wife of one of the richest men in Samboanli, had a low total inflow compared with other women. Thus the relationship between husband and wives has an impact on how much surplus production a woman can produce and invest.

Finally, the relationship women have with their natal families can have an important influence on their wealth. Gifts they receive from their natal families can be sold for profit, as was done by several women in Pentouangou. Furthermore natal families serve as leverage that women can exert in helping them to negotiate favorable conditions for themselves with their husbands. As we will see in chapter 8, a woman's natal family forms part of a network that can be called upon to access various resources such as land. Furthermore, as did some of the case study women in Samboanli, women can keep livestock with their natal family, thus keeping an important investment out of the reach of their husbands.

Aside from the different factors that can make a person wealthy, there is also the variability in these factors to consider. A question that we were consistently confronted with during the wealth rankings was for what time period the wealth ranking had to be made. In all three villages where wealth rankings were conducted (a secondary research village was also included) there was a difficulty in ranking households because of the frequent changes in people's situations. Respondents made references to events that happened such as an illness or an escaped wife that would make them continuously shift households from one wealth category to another. While the wealth ranking exercises proved fruitful for learning about these aspects of society, they also showed how ranking people according to wealth in such a variable environment may not be of much relevance for more than a very short period.

Sambo is a good example of the temporary nature of "wealth". Sambo was part of a relatively large household but both his mother and father died when he, the eldest, was still young. He did not have uncles whom could take over as head of the household thus he found himself head at an early age. He inherited his father's fields that were producing well. Sambo married a first wife and was able to invest in a bicycle, a donkey, and a plow all within a matter of five years. He married a second wife and that is when things began to go wrong. His second wife escaped because she did not want to be married to him. He consulted the elders and was told to kidnap her back, take her to a village where her lover's family could not get her because they had no kin relations there, and live with her there for one year all the while giving her some traditional medicine to get her to stay with him. He followed the elders' advice, but that year production was low as his first wife had a child, and his younger brother and his newly-wed wife were the only ones left to cultivate the fields. This resulted in having to sell the bicycle. The donkey got ill and died and the plow broke down. In a matter of two years Sambo's household went from being largely self-sufficient to having to borrow and receive gifts of grain to feed the family. This happened in 1992. Four years later his household was still regaining lost ground.

The elusiveness of wealth relates to the difficulty with which researchers can identify an indicator to rank individuals. It does not mean that villagers have no concept of who is wealthy and who is poor in the village. We asked three of our case study men to define the concept. The word for wealth is "*frm palu*" meaning strength or "he who has the capacity to do something". In each interview, examples were given relating to people with possessions such as cattle, a cart, a plow, and a motorbike. But when we pointed out that many men in the village would then qualify as being wealthy all three respondents pointed to the fact that a person with *frm palu* was one who had enough to help others. Thus fundamental to the concept of wealth is a mixture of having money or possessions but also using wealth to give to others. While this may seem a concept guided by religious beliefs, the three respondents were Muslim, Protestant, and animist, respectively. Rather using wealth to give to others is related to one's political power, one's social network, the family life cycle, and the number of household members. Villagers also know each other's history in order to weigh a temporary period of being poor with a longer-run wealth.

In summary, using money and material possessions as an indicator of wealth is too simplistic. Wealth also has to do with being at a moment in one's life cycle with few non-agriculturally active dependents, having a large social network, having political power, and luck that an unforeseeable event such as illness, death, or the escape of a wife does not occur at the wrong time. Additionally, for women, having "good" husbands and support from their natal family is also important. In essence, the difficulty with wealth categories, as they are customarily used in household surveys, is that they focus on the individual and his or her possessions. In a society where relationships between people are so important, this way of categorizing misses a great deal. Finally, the variability in the aspects that determine wealth can make it so that people can easily shift from one wealth category to another.

7.6.5 Commodities and non-commodities

Despite the widespread monetization of the local cultural economy, some resources have not fully entered the commodities world. Land is a case of a resource that has only partially been commoditized. General Sankara had expropriated all land and declared it state property as part of his campaign to undermine traditional chiefs during his rule between 1983 and 1987. Despite this and other previous attempts to undermine traditional authority (e.g. Maurice Yameogo (1960-66), the first president of Burkina Faso had prohibited the existence of local chiefs (interview with Tchiara Lankoandé), land in Gourmantché villages is not for sale. Land tenure in the villages is defined by customary law and the village chief is the central person presiding all major decisions about village land. First settlers of land have cultivation rights, newcomers ask the village chief for land on which to settle and cultivate, land can be borrowed, and villagers can claim "new" land by clearing it. However, land in cities and larger towns can be sold and rented as was the case in Fada N'Gourma and Bilanga, the closest towns to the research villages. In fact, during our stays in Fada N'Gourma (1995 to 1998) standardized plots were being delimited as part of the government's urban policy, creating at times problems for inhabitants whose house was divided in two by the new plan. Even the king of the Gourmantché was faced with a plot boundary running through the middle of his altar for the ancestors (interview with king Yuabili[149]). Thus both customary as well as market principles coexist in defining land tenure.

The coexistence of both principles regarding land is particularly striking in Bandia's case. Bandia bought a plot of land in Bilanga for his commercial activities. Yet at the same time he adheres to customary land tenure rules within his village even though he would greatly benefit economically by taking back a piece of low lying land that his grandfather had lent out to Hambila. Given their kinship tie (Hambila's great grandmother was from Bandia's family), Hambila was also granted the right to plant some mango trees on this land. This happened at a time when low lying land was not as important for crop cultivation as it is today (chapter 6). Hambila has now made an extensive mango orchard on that land which in 1996-97 brought him an income of over 200,000 fcfa. Bandia, who is struggling to feed his family, cannot take that land back because, as he said, "Hambila has not yet finished cultivating it."

Monetization thus, rather than supplant a traditional system of land tenure with a system of private property, has actually, as argued by Berry (1988), diversified the channels of access to land. This process is not without its struggles as we will see in section 8.3.

Labor is another category in which money has entered only partially given the attitudes surrounding paid labor. While people migrate to neighboring countries to act as temporary agricultural laborers, work on other people's fields for retribution is considered shameful and a measure of last resort. The differing attitudes towards paid labor are discussed in chapter 8.

A resource that is highly monetized is livestock. There are many reasons why livestock is one of the most preferred investment options in both villages, as explained in section 7.4.3, and its marketability is one of them. The Gourma and Gnagna provinces' geographic location, sandwiched between areas of livestock provenance (northern Burkina Faso, Mali and Niger) and areas of livestock destination (Togo and Benin), puts them in the middle of a flourishing livestock trade network. Unlike grains, there is never a dead period in which livestock are not sold and bought. The great monetary value of livestock, however, does not prevent it from being used in ceremonies in which it is sacrificed to ancestors. As we saw in figure 7.2, livestock was the fourth largest category of gifts given by the northern case studies. Furthermore, 10% of the value of all livestock transactions of all case study

[149] Interview on 22 March 1997, Fada N'Gourma.

individuals that occurred in the budget year in Samboanli were for direct use at ceremonies. This figure is an underestimation of the amount of livestock that is actually used at ceremonies because it does not include the livestock that is owned by someone and is directly sacrificed without a transaction occurring. An example would be the cocks that are used for sacrificing which are usually picked out of a person's court yard. Livestock thus is an example of a good that enters and exits the commodities world giving again testimony to the fact that both market and social principles mix rather than supplant each other.

7.7 Conclusion

Two findings emerge from this chapter about the study of an economy. First, that the cultural economy is the result of an integration of market principles and social considerations that have developed within a particular historical and cultural context. We found a high level of market integration given the historical presence of trade in the area. Market transactions in which products are bought and sold in exchange for money are conducted frequently and on a daily basis by the villagers in the two research villages. Furthermore, the budgets of case study individuals showed that large quantities of money and commodities flow through people's hands. People also know the price value of goods even when these are obtained through other than market channels, for example, through gifts or own production. Also, off-farm activities are conducted with profit-making objectives. An example is the lucrative activity of buying grain to resell later in the year when prices are higher.

At the same time though, we have seen how even in marketplaces, where neo-classical economic theory argues that relationships are reduced to an impersonal exchange of money for goods at prices determined by supply and demand, relationships between buyer and seller are important in setting the price at which a good is sold. We further investigated the role of relationships in the exchanges made by 35 case study individuals in the two research villages, and found that gift giving and interest-free loans comprised a large part of total expenditures. These are both ways in which people build and maintain social networks.

A second finding is that even within a relatively small geographical area, with populations of the same ethnicity, institutions can develop differently. For example, gift giving was found to be more important in the northern village, averaging well over one third of the expenditures of the case study individuals. In the south, instead, the institution of loan giving has been adapted to the increased monetization of society and the recent settlement of Fulbe so that monetary loans are used as a way to create and establish relationships of trust beyond kin groups.

These findings highlight the need for theories that allow different paths of institutional development rather than assume institutions to develop according to a pre-determined path towards a market economy. The coexistence of both market principles and social considerations within the local economy means that dichotomizing economies according to the substantivist and formalist schools is beside the point. The differences between the two villages, in fact, highlight that it is not possible to reduce the development of economic institutions to formulas such as more market development leads to a decrease in importance of social institutions. We saw that in the north, where markets have been more active and where women are more integrated in a market economy, gifts play a greater role than in the south. Also, in the south, where markets increased in importance at a later point in time, money has affected the way social relationships are forged with non-kin while this seems to be less so in the north.

Rather, we argue that a useful framework for understanding a local economy is to analyze the coexistence of principles and how they develop within the local historical and cultural context. This local economy in which different mixtures of principles are at play, we call the cultural economy. The study of the cultural economy puts emphasis on understanding local economic concepts such as money, labor, or even time. We saw that markets are not purely capitalistic while social institutions are not purely traditional. This results in economic decisions being guided by a mixture of principles. Attitudes towards money affect how savings are kept and the choice of off-farm activities; timing of investments can have just as much to do with life cycle and unforeseeable events, such as illness, as with prices and the availability of savings; the association of money with where it comes from makes the traditionally considered food crops of millet and sorghum, also cash crops with which large investments are made and, instead, groundnuts a cash crop with which basic necessities are met; and things such as money, labor, land, and livestock are both commodities and non-commodities.

In a study of soil and water conservation, the question of course arises as to how these aspects of the cultural economy affect soil and water conservation. We have seen in this chapter that crop production is the most important source of inflows: it constitutes an important part of people's consumption, it is the greatest contributor towards income, and it is the activity by which the majority of villagers define themselves. A somewhat surprising result then, is the scant investment made in arable farming in terms of purchases of equipment or external inputs. Why do people who have surplus production and savings invest only their labor for something that is so important to their livelihoods? Until now we have looked at how people use their money for crop cultivation. However, the analysis of the cultural economy has shown that principles of profit seeking mix with objectives of establishing and maintaining relationships (plate XV): people want to *earn* money but they also want to *build* social networks. This implies that to understand how people invest in agriculture, it is not sufficient to examine their monetary investments but also how they use social networks for agriculture. This is the object of chapter 8.

Plate XIII. Selling *soumbala* at the market while tending children

Plate XIV. Going to a market to sell chickens

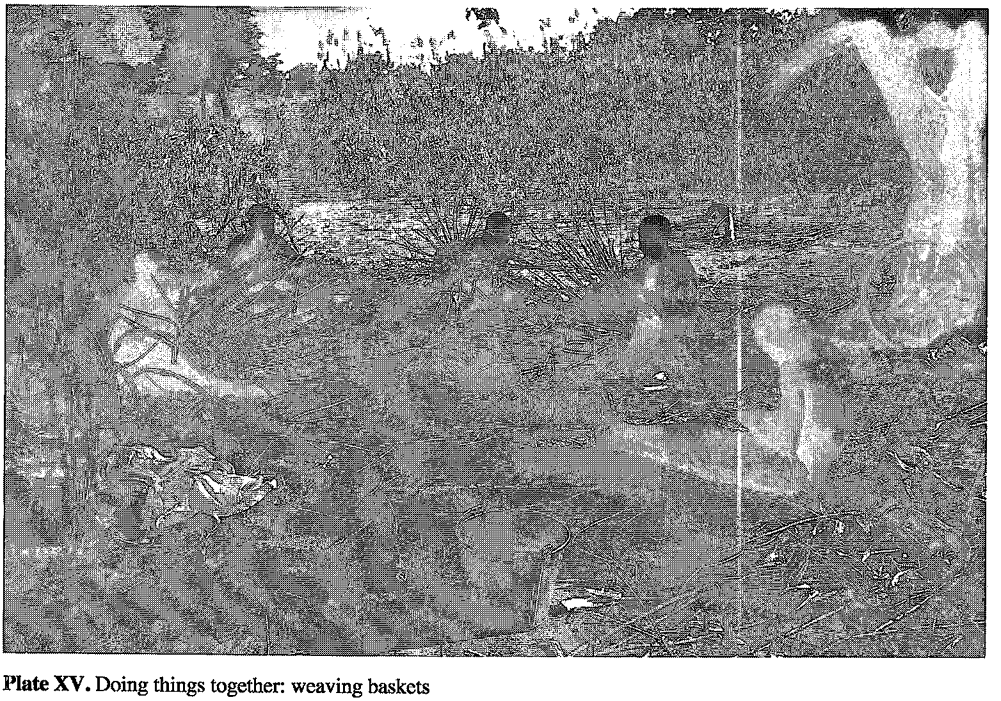


Plate XV. Doing things together: weaving baskets

8. The many roads to intensification: accessing resources to conserve the land

> ...any theory or model or paradigm propounding that there are only two possibilities – disaster or one particular road to salvation – should be prima facie suspect. After all, there *is*, at least temporarily, such a place as purgatory! (Hirschman 1970: 337)

We have seen that there is a lack of evidence of land degradation in the study region, and that land cultivated per person has been declining while yields instead have been rising (chapter 5). This would indicate that there is some form of intensification happening. Chapter 6 looked at what farmers are doing to make such a situation possible and found an intensification of the use of agronomic/biological practices. However, farmers not only require the skills and knowledge to apply these practices, but they also need access to certain resources. In this chapter we will use aspects of the cultural economy (chapter 7) to understand the social organization that makes access to resources and technologies possible.

In a first section we review how institutions are considered in studies on intensification. In section 8.2 the utilitarian aspects of social networks are briefly explained. How land and labor are accessed is the focus of sections 8.3 and 8.4, respectively. Because women's role in agriculture has greatly changed within the past century, section 8.5 looks at how women's natal networks contribute to accessing resources for agriculture. Section 8.6 examines relations between Gourmantché and Fulbe because these, through their influence on livestock activities, affect people's livelihood strategies. Section 8.7 looks at how people access equipment and inputs and section 8.8 at how they access cash to meet their increased monetary needs. The chapter concludes with a discussion on how this agricultural system has exhibited forms of intensification that are quite different from the capital-led path that is advocated by the dominant development narrative.

8.1 Theoretical interlude: paths to intensification

Theories on intensification have led to a focus on labor and technology as ways to pursue both productivity and environmental sustainability objectives (chapter 2). Furthermore, there is a widespread view that labor intensification alone is insufficient. Systems of high labor and low purchased input use such as Low External Input Sustainable Agriculture (LEISA) are judged as having the potential to increase food production by only 1 percent a year which is too slow to meet Africa's 3.0 to 3.5 percent annual growth in food demand

(Ruttan 1990). Increasingly economists argue that to meet both productivity and environmental sustainability objectives, LEISA techniques such as mulching and alley cropping should be used in conjunction with what they term farm capital, that is, inorganic fertilizer, equipment (such as animal traction equipment and tied ridgers), and soil conservation infrastructure (Sanders *et al.* 1996; Reardon 1997). Thus technology intensification in the form of increased use of farm capital tends to be the focus of most studies on the productivity and environmental sustainability of African agricultural systems.

When this form of technological intensification is not found, solutions are sought in policies, prices, and infrastructure that help promote investments in farm capital such as: investing in rural infrastructure which would reduce transportation costs; improving input and output markets thus making inputs available to farmers and giving them a vent for their surplus production; reforming macroeconomic policies to "get prices right" by liberalizing markets and eliminating overvalued exchange rates that create disincentives to production of tradable agricultural products; improving farmers' access to rural credit and non-farm income by rebuilding rural credit institutions and promoting non-farm income earning activities (such as de Janvry *et al.* 1991; Reardon 1997). These recommendations focus primarily on the *availability* of resources (rural infrastructure and markets) and on making them *accessible* through money (credit markets, non-farm income). However, as Sen's (1981) entitlement approach extended to questions about the environment shows, these aspects of availability and accessibility have too narrow a focus in order to understand the dynamics that underlie land use and environmental change (chapter 2).

Parallel to the emphasis on technology intensification, is the emphasis that agrarian capitalism provides the appropriate institutional climate for productivity and environmental sustainability. Not surprisingly, if the above recommendations were to be implemented exactly, a perfectly functioning, capitalistic system would result. Furthermore, there is the tendency to consider social institutions such as social networks, in opposition to agrarian capitalism, and therefore as detracting from agricultural productivity. When studying social networks, economists focus on their insurance function in reducing incentive problems and covariate risk (Binswanger and McIntire 1987; Platteau 1991; Fafchamps 1992).[150] In fact, what we term social networks in this study, are usually called mutual solidarity systems, mutual insurance, or traditional systems of social security in economic literature. When their relationship to agricultural productivity is discussed, they are generally viewed as hampering productivity (Reardon and Vosti 1995). It is argued that social networks take resources away from investments in farm capital by requiring the use of resources to give gifts, pay dowries, or conduct certain types of exchanges to build relationships with other people. Even amongst anthropologists who have given detailed attention to the workings of social networks, there is the tendency to consider these institutions as detracting from productivity. Berry (1988, 1989), for example, explains that production systems based on social identity promote the investment of resources in social relations rather than in direct

[150] Incentive problems arise when agents act in an opportunistic way and try to "free-ride" while covariate risk is when agents face similar risks and therefore cannot reduce each other's risks by trading them. For a detailed discussion of these with relationship to networks see Platteau (1991).

increases in productive capacity. Lewis (1981) also argues that land is inefficiently worked when production systems are based on networking.

In the agricultural system under study, farm capital is relatively little used (chapter 6) and social networks play an important role in influencing economic action (chapter 7). At the same time, however, yields have been able to keep pace with a rapidly increasing population without leading to evidence of land degradation (chapter 5). This chapter aims to reconcile these two contrasting tendencies by focusing in a broader way than do the economic studies on intensification mentioned above, on how people access resources. Such a focus helps understand how the social organization of production affects the productivity and environmental sustainability of a production system. We do this by studying how institutions guiding resource access have shaped and been influenced by conditions of agricultural production in reaction to a changing physical and social context in which agriculture is practiced, i.e., we focus on agrarian change.

8.2 A preliminary note on utilitarian friendships

Chapter 7 looked at the resources that people allocate to creating and maintaining relationships with other people through giving and receiving gifts, interest free loans, and even through market transactions by giving and receiving discounts. However, there is no such thing as a free gift. As was explained by Mauss (1990) as early as 1925 in his seminal book *The Gift*, every gift implies an entering into a relationship with someone and this relationship binds the giver and the receiver into a series of transactions. The ensuing transactions reinforce the relationship but can also be of practical utility to the actors involved. The concept of special friendships among Gourmantché men can help illustrate this point.

Special friendships have been described for various West African societies (e.g., the Kabre of northern Togo by Piot (1991), and the Mossi in central Burkina Faso by Breusers (1999)). Also in Gourmantché society friendships with a special significance can exist between two men. A man will usually have one or two special friendships in a lifetime. When asked how such friendships are formed, a respondent explained, "you begin by telling something to this person and if they keep it a secret, you will keep going with the friendship." The friendship is referred to in terms of what the persons will do for each other. As another respondent explained, "this person is the one who will help you out under any circumstances. You can also ask him for things that you need for future projects of yours and he will not tell anyone else. If your project does not work out, it will not be a loss of honor for you because no one knew about it except for your friend." Thus even the most special of friendships are described in terms of what friends will do for each other.

The gifts, loans, or discounts analyzed in chapter 7 help create and maintain social networks. However, it is not sufficient to say that social transactions are important in society. Social networks resulting from these transactions are also utilized. This chapter will focus on how people use their networks for agricultural purposes and how these relate to the agricultural practices described in chapter 6.

8.3 Accessing land through networks

Land is both a commodity and a non-commodity, it can be sold at times and in certain places, while in others it remains outside of market transactions (chapter 7). In both villages, however, land is not for sale nor is it rented. Cultivation rights are obtained by clearing a piece of land that has never been cultivated before. Thus the founding families of a village are those who have the oldest rights to village land. The village chief is responsible for giving the right to newcomers to cultivate on village territory (Swanson 1979a).[151] Women do not own land but are given the right to cultivate it by their fathers' lineage until they marry and then by their husbands' lineage.

Borrowing of land is also part of the customary land tenure system. Anyone wanting to cultivate a piece of land that has been cultivated in the past can borrow that land by asking permission from the original cultivator or his inheritors (Swanson 1979a). A borrowing agreement does not entail a predetermined payment. However, a tacit agreement exists that a borrower must show "respect" to the lender. Respect may entail showing loyalty in cases where a lender is in a political or social confrontation. Another example given by a respondent is if the lender needs millet he may ask the borrower of his land to sell him any extra millet he may have. If the lender does not sell to him but is seen selling his millet in the market, the lender will take his land back given the lack of respect that was shown him. The notion of respect in return for borrowed land is similar to what de Zeeuw (1997) found in western Burkina Faso.

The borrowing agreement usually allows the borrower to cultivate land until he has "finished cultivating it". General practice is to cultivate land until it is ready to be left fallow. Once land is left fallow, the right to cultivate the land returns to the original owner. The idea that a borrower of land must "finish cultivating it" before the land returns to the original owner explains why planting trees is a form of gaining virtual permanent rights to cultivate a piece of land: as long as a planted tree produces, the borrower is still cultivating the land. Therefore, the planting of trees on borrowed land is forbidden unless permission is given by the original owner of the land (Swanson 1979a). In some cases the original owner may give that permission as happened in the case of Bandia's grandfather (see section 7.6.5).

How does this system of land tenure affect how agriculture is conducted? As we have seen in chapter 2, private land tenure is considered a necessary step towards economic growth in theories of intensification (Boserup 1965; Hayami and Ruttan 1985; Binswanger and McIntire 1987). The assumption is that private land tenure provides the appropriate incentives for investing in land through technologies. Private land tenure gives the security to the owner of a piece of land that he or she will benefit directly from any investments made on the land and can foreclose others from "free-riding", or benefiting without having made a contribution. Customary land tenure systems, by contrast, are considered insecure and too "inclusive" (Timberlake 1985; Bassett 1993; Lambert and Sindzingre 1995). Yet another reasoning is made by Berry (1988) in which she argues that if access to land and other productive resources depends on social identity, as is the case in customary land

[151] Gourmantché do not have an earth chief as do Mossi.

tenure, resources will be used to establish and reaffirm advantageous identities. This results in "the overuse of resources within a given enterprise and a tendency to invest in social relations rather than direct increases in productive capacity" (Berry 1988: 67). Additionally, various changes in African societies, such as the commoditization of agriculture, she argues, diversify the means of access to wealth and power thus aggravating the struggles to lay claims to land. All of these arguments lead to the conclusion that customary land tenure systems discourage and diverge investments to the land.

Disputes over land rights do exist in the research area, but whether these have increased with the changes undergone in Gourmantché society in the past century, is difficult to determine given the lack of written documentation. Colonial judicial documents have very few cases of land disputes[152] but this is more a reflection of the fact that land disputes tend to be resolved through customary law rather than in official courts. Disputes can happen between inhabitants of the same village, border disputes between adjacent villages, or disputes between different land users such as agriculturists and pastoralists. Two examples from the southern village can help illustrate the kinds of disputes. A particular controversy which was the source of most of the land disputes amongst Gourmantché during the period 1995-97 in Pentouangou concerned a low lying bottomland (bas-fond) located on the border between Pentouangou and a neighboring village. Declining rainfall trends have meant that the once swampy, uncultivable, bottomlands between the two villages are now just wet enough to cultivate the rice landraces available in the area. As families are seeing the monetary benefits of those who are now growing rice, people from both villages are claiming their historical ownership to the bottomlands. Another example is of Gourmantché-Fulbe disputes. The recent settling of Fulbe pastoralists within the territory of Pentouangou has brought lands deemed appropriate by Fulbe as watering points and cattle paths into dispute. Contrary to how disputes between Gourmantché, such as those described above, tend to be resolved, those between Gourmantché and Fulbe are frequently brought before government authorities (interview with Dr. Boly, director of the SPRA in Fada N'Gourma until March 1996[153]).

Despite these disputes and the fact that in nearby towns land is a commodity, customary land tenure seems to be perceived as secure. Our findings concur with the growing amount of literature showing that traditional tenure arrangements do not act as a disincentive to invest in land (Barrows and Roth 1990; Gavian and Fafchamps 1996; Ouedraogo *et al.* 1996; de Zeeuw 1997). None of the countless interviews we had with farmers on their use of soil and water conservation measures revealed that land tenure was a consideration they made when deciding whether or when to invest in soil and water conserving measures. Furthermore, and contrary to the findings of Gavian and Fafchamps (1996), the temporary rights to cultivate land gained from borrowing seem to be perceived by farmers as secure. The six in-depth cultivation histories conducted with some of the case study individuals in the two research villages revealed no relationship between form of

[152] For example, there was only one such case in judicial documents of the colonial administration in Fada N'Gourma from 1913-1916 (DOS.TBX. 13-14, DOS.TBX.15-16) and one in documents from September 1950 to March 1951 (DOS.PAL.50-52).

[153] Interview on 12 February 1996, Fada N'Gourma.

tenure (borrowed or ancestral land) and use rights (individual or household field) on the one hand, and agricultural decisions and cultivation practices on the other. In all cases it was found that farmers applied soil and water conservation practices to adjust to the changing qualities of the soil due to cultivation. Farmers therefore often increased the amount of soil and water conservation activities towards the end of the cultivation period in response to a production decrease on certain parts of the field (chapter 6). The fact that such a field would soon be left fallow or be used by someone else was never mentioned as a concern and is exemplified by the following comment made by a farmer: "If you know that you can use a piece of land that you borrowed from someone for more than two or three years, it is worth guarding the land well (*ki kubi ki tinga*) by making stone lines, wood barriers, or planting grass strips. If someone lends you a piece of land you are going to guard it as if it were your own" (interview with Adama Yenloli Nadinga[154]).

Various reasons contribute to borrowed land being perceived as secure. The possibility of having land taken back by the borrower is not seen as a real threat because, as explained above, it depends upon the lender's own behavior. Furthermore, as borrowing occurs most often between kin, there is a lot of social pressure on the borrower not to take back land when the lender has not acted in a disrespectful way towards him.

Borrowing land contributes to making the agricultural system flexible and able to adapt to the changing conditions under which agriculture is practiced. For example, borrowing land allows a shifting cultivation or bush-fallow rotation system to exist at greater population densities than if borrowing did not exist. Borrowing land as opposed to clearing new land is increasingly becoming necessary due to the declining availability of unclaimed land. This is because of the tenure system described above of how claims to land are made. In a system of shifting cultivation, where people cultivate land until it needs to be left fallow, land will be progressively cleared and therefore "claimed" while fallows are allowed to regenerate. This means that the early settlers of a village will have cleared and claimed more land than recently settled villagers. As more people inhabit an area, borrowing land allows those people who have "claimed" less land (such as late or newcomers) to borrow fallow land from people who have "claimed" lots of land.

Borrowing also allows farmers to adjust the amount of land they cultivate to the changing availability of family labor. Today's smaller production units are more susceptible to fluctuations in family labor due to life cycle stages and to unpredictable events taking family members out of production (discussed in section 7.6.3). If land is borrowed, people can work less land due to a fall in family labor availability without incurring a monetary loss as they would had they purchased or rented the land and had to pay mortgage or rent on it. Conversely, if the situation arises that one can expand the amount of land one cultivates due to a member entering production, or if the stage of a field's cultivation cycle does not require as much labor to be spent on certain tasks,[155] then borrowing land gives the possibility of expanding the limits of one's field in accordance with the availability of labor. An example was provided by Sambo. In 1996 he cleared and

[154] Interview on 25 September 1996, Samboanli.

[155] For example, the first years of cultivation require more labor for clearing the land while the last years may require more labor for weeding.

cultivated a piece of inherited land. Clearing land is a highly labor intensive activity and determines how much land one can sow. Sambo explained that the advantage of that piece of land was that if he found he had extra time the following season due to the fact that land did not need to be cleared, he could easily expand his field by borrowing adjacent pieces of land from his neighbors. He was sure he would be granted permission because he would only be asking for small pieces of land distributed amongst various neighbors. In a private land tenure system where fixed-sized plots of land are sold, such adjustments of adding land on a piecemeal basis would not be possible. This flexible system of land use allows farmers to adjust the amount of land that they use to their availability of labor, thus making optimal use of their labor without incurring costs if they are not able to work all of the land.

A recent survey (MARA 1996a: table 28) showed that in the eastern region some 15% of the cultivated plots is borrowed. However, based on a 1978 survey cited in Swanson (1979a) that shows 27% and our own experiences, we have the impression that borrowing is considerably under-represented in this recent survey because of the difficulty in addressing such issues in questionnaires. The relations used for borrowing land were usually based on kinship, in which relations through the husband's or wife's lineage were used. The breadth of the network of people from whom land was borrowed allowed even land outside of the village territory to be accessed. In fact, all three heads of households with whom we conducted detailed cultivation histories in Samboanli had cultivated at least once outside of village territory for periods ranging between eight to ten years. Such use of social networks makes it so that people, including those not from the founding families, are not forced to over-cultivate their own land, but can, when the time comes, leave their field fallow and in so doing contribute to the conservation of their land.

Before we conclude this section, it is necessary to point out that borrowing land makes the practice of fallowing possible but, conversely, the kind of technologies used make a system based on borrowing viable. That is, given the type of technologies used in the region, land will only produce for a finite period, after which it is left fallow and cultivation rights return to the original owner. Were technologies such that land could be cultivated more permanently, borrowing land may become more difficult. The planting of trees is a contentious issue precisely because trees can turn the borrowing period from finite to infinite (at least in terms of generations). Thus, as long as lenders do not feel their rights to a piece of land threatened, they will lend out land. However, given the mixing of market and social principles in the cultural economy (chapter 7), it is a quantum leap to assume that if the type of technology were to allow permanent cultivation, land tenure would become privatized. Even in more commoditized agrarian systems with permanent cultivation such as in the western Nigerian cocoa belt (Berry 1975), cocoa and coffee farms in Cameroon (Weber 1977) or systems such as those in western Kenya (Shipton 1992) where land titling took place, land tenure is nonetheless not fully privatized.

We have seen how the land tenure system, through borrowing, provides the mobility that allows people not to over-cultivate their lineage land as well as the flexibility that allows them to adjust their land needs in accordance with changing labor force and production needs. Borrowing of land is only possible through social networks. This does not mean that borrowing will always be an option, but we argue that borrowing is part of the way people adapt to changing conditions such as increases in population, changes in climate, or new market opportunities, which makes them more adaptable than theories about population pressure imply. It is the way people adapt that needs to be understood, rather than assume societies to be at some "stage" toward a population threshold.

8.4 Changing access to labor

As was argued in chapter 7, today's smaller production unit is more susceptible to large labor fluctuations. Any event taking members out of production such as illness, death, or birth, or a stage in the life cycle when the ratio of consumers to workers is high, means that a larger proportion of total family labor is unavailable for agricultural work than when production units were larger. Consequently, small production units are in greater need of temporary labor. Accessing this labor can be the difference between having a harvest or none at all because agricultural tasks such as clearing a field, weeding, or harvesting, if not done on time will jeopardize the entire harvest.

Greater market integration and the cultivation of cash crops are seen, by intensification theories, as precursors to a labor market (Boserup 1965; Hayami and Ruttan 1985). Indeed, the incomes of certain case study individuals would have theoretically allowed the hiring of temporary labor. However, in the study area, labor is one of those aspects of society that has only partially entered the commodities world (chapter 7). In fact, there was not a single transaction paying for agricultural laborers in the two years for which budget data were collected. Field histories, which were conducted with six married men, revealed only one example in the southern village of a Mossi laborer being paid for tilling and harvesting activities. The laborer came from another village and was hired to help out with non-farm related activities such as cutting wood to sell but was used in times of peak labor needs for agricultural tasks. He was paid 6,000 fcfa per month and was hired for two months. But labor that is expressly hired for agricultural work is hard to come by especially due to the attitudes that surround paid labor. Working on someone else's fields is looked upon with shame among the Gourmantché because it is taken as a sign that one cannot produce enough to sustain one's own family. In fact, when explaining in a wealth ranking why a head of household was categorized as the poorest, the respondents explained, lowering their voices even though we were far from anyone's earshot, that he was a person who had to work on other people's fields. Earning money as hired farm labor is seen as a last resort.

The kind of agricultural labor, though, makes a difference in attitudes towards it. If one is called in for one's skills, for example, the ability to use a plow, then the labor is not considered shameful. This is prevalent among sedentarized Fulbe who hire Gourmantché with plows to work on their fields. This occurs at a time after the Gourmantché has finished plowing his own fields. Weeding on the other hand, happens at a peak labor period when everyone should be working on his or her field. It is also not done with any special machinery and therefore does not require a special skill. So weeding someone else's field for money is a sign that one does not have enough to support one's family. The situation is different for hired non-farm employment which is generally done during the dry season and is not seen as shameful as it does not detract from agricultural activities on one's own fields and may actually show one's abilities or skills in other areas. Finally, working as a paid agricultural laborer while on temporary migration is not viewed with shame as one is far from one's own fields and earning money is a major reason why people migrate.

Thus, how do people access labor outside of their households now that it is increasingly needed? Social networks have provided a means through which people have adjusted to this new necessity. An indication of the increased use of networks to access labor can be seen through the changing use of work parties: their function has swayed from prestige to production purposes and the networks used for work parties have somewhat changed in composition.

Work parties, in which people are invited to work on a person's field in exchange for a meal and/or drinks (plate XVI), have two functions. The production function is evident: through the work party a person is able to catch up on important tasks such as harvesting that, if not done in time, can make the difference between having a harvest and not having one at all. Richards (1986) even found that the major factor distinguishing farms with high and low yields in Sierra Leone was their access to work parties. However, there is also a social function of work parties in that the caller of the party exhibits and reinforces his social standing by having many people show up at his work party and offering lots of food, local beer (*dolo*) and tam-tam music to make it a festive occasion. Remy (1967), studying Gourmantché villages to the southeast of the research area, points out that work parties were not always beneficial from an economic point of view: the offerings cost much more than the benefits of the work produced, which was done in a hurried manner and thus of bad quality. Such large work parties had more the effect of reinforcing the host's prestige and status within the community, and thus had more a political rather than a production purpose.

Today work parties tend to be smaller and done more for purposes of production rather than prestige. This comes out both in the number of small work parties we recorded for the case study individuals during the agricultural season, as well as through respondents' recollections. Furthermore, the village survey reveals that they are pervasive as there are on average 1.6 and 1.4 agricultural work parties annually called per household in Samboanli and Pentouangou, respectively (see tables C.6 and C.7 in appendix C). Table 8.1 shows that work parties called by case study individuals were relatively small, averaging 16 participants per party which is considerably lower than the marriage-related work parties that have a definite prestige component and range between 25 and 100 participants. These figures are similar to the village survey which revealed an average of 18 and 21 participants per work party in Samboanli and Pentouangou, respectively. We also see that expenditures per individual present do not follow a clear pattern with the wealth of the person hosting the work party (thus no clear political/social significance). Indicative of the production orientation of labor parties is that 8 of the 13 work parties were called by poor to middle wealth families and that all but one of the people who called these different work parties were running behind in their cultivation tasks.

Respondents further confirmed this trend. Three men between the ages of 40 and 60 interviewed independently on this topic concluded that work parties today, as compared with 30 or 40 years ago, consist of fewer people, are more frequently called, and are less

Table 8.1 Agricultural work parties of case study individuals, December 1996 to November 1997

Person	Activity	Crop	Field type	Total pp's[a] (no.)	Bush neighbors (%)	Kin[b] (%)	Area pp^{-1} (ha)	Costs pp^{-1} (fcfa)
Bandia[c]	land clearing	sorghum	bush	22	9	95	0.109	186
Bandia	weeding	sorghum	compound	10	30	100	0.035	280
Bandia	cutting stalks	millet	compound	3	67	100	0.216	300
Piampo	weeding	millet	bush	50	0	0	0.069	217
Possi	weeding	millet	village	2.5	n.a.[d]	100	0.182	120
Possi	weeding	rice	bush	20	75	100	0.019	160
Djoulmani	weeding	rice	bush	8	50	50	0.222	250
Djoulmani	weeding	rice	bush	22	68	100	0.081	314
Djoulmani	cutting heads	rice	bush	17	29	71	0.105	353
Marhi	weeding	sorghum	bush	15	60	27	0.030	213
Marhi	cutting heads	rice	bush	9	67	22	0.104	222
Sambo	hoeing	sorghum and millet	bush	16	63	25	0.201	219
Noaga	second weeding	millet	village	15	n.a.	100	0.208	133
Average				*16*			*0.122*	*228*

Source: Agricultural study.

[a]pp = participant.

[b]Bush neighbors and kin are not mutually exclusive.

[c]The same person and crop does not mean it is the same field.

[d]n.a. = not applicable and applies to cases in which the person calling the work party did not have a bush field.

festive in that tam-tams are much less frequently played (interviews with Yempani Guida[156], Djalambiga Lankoandé[157], and Foldjoa Thiombiano[158]).

Marriage-related work parties occur on the communal grain field of the father or uncle of a bride-to-be. Her fiancé, in order to obtain approval from the girl's family, must organize a work party to sow and harvest the girl's groundnut field and, more importantly, the father's or uncle's communal grain field. The father or uncle provide the food and refreshments. As this is a work party that is not requested by the receiver, it is purely an invitation related to prestige: the more important the father or uncle is in the community, the bigger must be the work party. In table 8.1 this kind of work party is represented by the one of Piampo and organized by his niece's fiancé who comes from another village. This explains why none of the participants were kin or bush neighbors. It is interesting to note, however, that it is not distinguishable from the others in terms of the area per person nor how much was offered per person.

The second change that has affected work parties is the greater use of bush camps (chapter 4). Bush camps are usually settled close to other bush camps. This is because neighbors can help each other for example in protecting their fields against cattle and other

[156] Interview on 21 February 1997, Samboanli.

[157] Interview on 20 February 1997, Samboanli.

[158] Interview on 12 March 1997, Pentouangou.

animals.[159] However, households within a same village compound will settle in bush camps in different farming areas. This is a way to spread risks against localized production fluctuations. Consequently, bush camp neighbors will be from one's extended kin group or even non-kin relations. Given the distance that these bush camps can have from a village, meeting temporary extra-household labor needs means calling upon one's bush camp neighbors. This requires having a network of people beyond one's own kin.

The importance of bush camp neighbors as well as the kind of composition of networks that bush camps entail can be seen in the number of bush camp neighbors that participated in the work parties called by case study individuals (table 8.1). The only people who did not have any bush camp neighbors participate were those who did not cultivate on a bush camp (Possi and Noaga) or the one person who had a marriage-related work party in which people from the suitor's village came to work (Piampo). In the case of Marhi and Sambo who cultivate in two different bush camps, many of their neighbors who participated were not related by kin. They have a relatively small network of kin relations thus building networks with field neighbors seems to be all the more important. In fact, Marhi was difficult to locate during the rainy season because he was often working at his neighbors' work parties.

The possibility that networks give to access temporary labor adds flexibility to the agricultural system that allows people not to over-cultivate the land. For example, accessing labor to clear previously uncultivated or fallow land (both highly labor intensive tasks) allows a production unit to move to new land rather than be forced to over-cultivate its own lineage land due to lack of labor. Also, going to a new piece of land involves some unknowns: one knows how one's own field produces but one can never know exactly how a new field will produce. Networks also allow taking this risk through accessing gifts and loans of food that may be necessary during the first years when a new field produces less. By completing agricultural tasks with work parties, time is also freed for applying the agronomic/biological measures that farmers use (chapter 6). Work parties also allow a farmer to use the family labor available to him optimally. This is because clearing is a task that only men do, thus calling a work party to clear the communal fields of a household head allows a large enough area to be cleared that can then be sown, weeded, and harvested by the labor available to the production unit. Finally, access to networks allows small production units to compensate for the dramatic lurches in household labor so as not to jeopardize production.

The example of Bandia can illustrate how work parties and bush neighbors allowed him to (a) clear a new field when his lineage land needed to be left fallow, (b) take on the uncertainties of a new field, and (c) continue his off-farm activities, at a time in his life cycle when he had many obligations and few workers. Bandia moved to a bush camp in 1996. He moved there because the field he had been cultivating on village territory had reached a point of not producing well and needed to be left fallow. Bandia called a work party to clear the land (table 8.1). He borrowed the land from a kin relation but chose that spot also because it was close to Piampo's bush camp. This gave Bandia the opportunity to see how Piampo's crops were faring in the new area but also to benefit from his relations

[159] This is also one of the reasons found by Senechal (1970) working in three villages 70 km NNW of Samboanli.

with Piampo. Piampo and Bandia have a noticeable relationship. They are often to be seen in each other's company and in our conversations with Bandia, Piampo was often mentioned. They explain their noticeable relationship through a common grandmother. However, they are quite different: Bandia is a practicing Muslim and Piampo a practicing Protestant. Piampo is a farmer with very few side activities. He is reputable in the village as a very good farmer and has a lot of knowledge about both the physical environment as well as agricultural technologies. He has always been able to produce enough to feed his family. Bandia, on the other hand, has been very active in commercial activities, first selling products he brought from Togo, then buying and reselling grain and livestock. He is often to be found in markets. He is also involved in different community and network building activities around his religion (rebuilding a mosque, going to markets to talk with other merchants, etc.). All these activities took him away from his bush camp quite frequently during the 1996 agricultural season. During the rainy season he tries to stay at home to cultivate but nonetheless, even then, some of these activities take him away for several days at a time. This means that he leaves his wife with three young non-agriculturally active children at home, alone and he therefore has temporary extra-household labor needs. In fact, during our visits to Bandia, we often found one of Piampo's daughters preparing the meal for Bandia's household, freeing his wife's labor for agricultural tasks.

Another substantial help was noted in the number of food gifts that went from Piampo to Bandia. Bandia's household was a deficit producing household for the years that we conducted our study due to various circumstances: illness and death of his father, non-cooperation of a third brother in contributing to household duties and expenses, and the move to a new field which always in the first years produces less (chapter 5). Food gifts and loans were thus essential for his family's survival. We see from the budget and stock data that Piampo's first wife lent Bandia's family at least 100 kg of millet during the hungry season. The price she said Bandia would pay her for it was 15% lower than the going market price at the time of the loan. In the same period he also received a gift from Piampo of 2,000 fcfa.

Thus, through the work party and the gifts of food, labor, and money that he received from his bush camp neighbor, Bandia was given the room to make choices that are right for the land by letting a field fallow, and not to have to abandon his off-farm activities, even at a time in his life cycle where his family labor availability is limited. Without networks as a means to access labor and gifts, Bandia would have been forced to stay on the field he was cultivating, accept declining yields, be forced to give up his commerce activities to work on his field, and consequently could easily have fallen into the poverty trap that is often seen as one of the causes of degrading agricultural practices (Hudson 1991; Cleaver and Schreiber 1994). This shows that even if land is available, a whole social organization around production is necessary in order to be able to practice a bush-fallow system of cultivation.

In this section, we have seen how people have adjusted the institution of work parties to adapt to the changing conditions under which agriculture is practiced. Work parties have long been part of the agricultural system, however, both their function and their composition have changed towards becoming more production oriented as well as including networks of people outside of one's own kin. This is a small but significant change. The access to temporary labor is what gives people the room to maneuver in an otherwise increasingly resource-tight system. With this room, people are able to practice agriculture in a non-depleting way.

8.5 Women in agriculture and their new use of networks

Women's use of networks for agricultural activities is an interesting example of how networks are increasingly being used for agricultural purposes. Women have become increasingly involved in agriculture in the past half century. Interviews with women between the ages of 50 and 70 revealed that their mothers did not have their own grain fields (interviews with Tani Lankoandé and other elderly women[160] and Bandienpua Thiombiano and Folpoa Thiombiano[161]). They confirmed that they were of the first generation to begin cultivating their own grain fields. When they were young, their mothers cultivated occasionally on the household head's grain field, helped with cotton harvests, and cultivated some sauce ingredients on their husband's field such as okra and rosella. Only elderly women, especially widows, were free to cultivate their own fields. What they recalled as being their greatest household task outside of preparing meals and caring for children was spinning cotton (plate II). They needed to spin enough cotton (weaving is a man's task, see plate III) to be able to make a shirt, a pair of pants, and a blanket for their husbands and any other man living in their household, and for themselves a cloth to wrap around their hips and a blanket. Ideally, they spun enough cotton to make new clothes each year. Spinning thus comprised months of work for a woman. But it was not arduous work as it could be done sitting under a tree within the compound, while talking, keeping an eye out on children, and preparing meals.

Within the lifetimes of these women interviewed, however, their role in agriculture dramatically increased. The growing importance of markets in their every day lives discussed in chapter 7, coupled with the presence, since the early 1970s of "western" products, created a need for women to have money. It became easier and cheaper to buy western-style clothing than to spin cotton. Modern medicines and school fees also became a household expenditure to which women contribute. Other household needs that are of women's responsibility such as plates and pots for cooking or earthen jars for storing water also became commercialized.

In both villages there has been a progressive decline in the customs guiding which crops could be grown by women and when. These changed to accommodate new needs. Half a century ago, for example, women in the northern village could grow Bambara groundnuts and okra only if one of their children had died. Only elderly women could cultivate tobacco because all other women would become blind if they did so. Customs at first adjusted so that women had to wait some time after their marriage before they could cultivate their own fields. For example, in the north, newly-married women could sow neither sorghum nor cotton because they needed to have a grown-up male child who could sow these crops for them. In the south women could not cultivate millet if they did not have

[160] Interview on 6 March 1996, Samboanli.

[161] Interviews on 5 March 1996 and 11 March 1997, Pentouangou.

a child. They could have a personal field only if they had a child old enough to help their husband on the family's grain field. Later, it became that they had to wait the third year after their marriage before they could begin to cultivate a personal field. Progressively, the time that they had to wait to cultivate their own field diminished so that today, both in the north and in the south, customs restricting when or what married women can grow are virtually non-existent. In fact, today children, including girls, begin at around 8 years of age to cultivate their own groundnut fields. In practice, the restriction determining when a woman can begin cultivating her own grain and groundnut fields is her life cycle. Before marrying, children are given time by their parents to cultivate their own fields. In the first years after marriage, instead, women have less time to cultivate because most of their time is taken up by caring for small children. Later on in their life cycle when they have older children to care for the younger ones, they can dedicate more time to the cultivation of their personal fields.

Today, upon marrying, women are given land from their husband's lineage on which they have usufructuary rights. All that they cultivate is theirs to sell. However, if a husband is not capable of cultivating enough for the family's consumption needs, women contribute their grain.

Women's role in agriculture has not only increased due to their cultivating their own fields, but also because they are more active on the head of household's communal grain fields. The fact that production units are becoming smaller makes women's labor an increasingly important part of a household's total labor force available to work on the husband's communal grain field. Women now work on the husband's communal grain field during the main hours of the day after they have attended to household matters like child care and meal preparation. Early in the morning or late in the afternoon they can cultivate their own individual field, or *suali kuanu*, which means afternoon field. Co-wives have more time to dedicate to their personal fields because they share the responsibility for meal preparation. In fact, amongst the six case study households for whom field-level data were collected, co-wives cultivated an area 20% greater than single wives in the north and 40% greater in the south.

There are differences in women's role in agriculture between the southern and the northern villages. In comparing life histories of women in Samboanli and women in Pentouangou it appears that women in the south lagged a few decades behind their northern counterparts (interviews with Tani Lankoandé and other elderly women and Bandienpua Thiombiano and Folpoa Thiombiano). In the north, women aged between 50 and 60 years of age were cultivating their own fields of grain and groundnuts a few years after they married whereas women of the same age cohort in the south were cultivating only sauce ingredients at that time. This was further confirmed by a veteran extension agent whom had worked in the region since 1958 (interview with Bernard Lompo[162]).

Data from the case study women shows the effects of this later entrance into agriculture in the south. The amount of land cultivated by the southern case study women for whom field information was collected (a total of six women) averaged 0.3 hectares whereas their northern counterparts (a total of eight women) averaged one hectare. These

[162] Interview on 11 April 1997, Fada N'Gourma.

average figures are partially influenced by the fact that there are more young women in the southern case studies than in the north and therefore, as explained above, are at a stage in their life cycle when they cultivate less. However, in comparing women of the same age cohort, the same trends appear. For the older women, Mindiba in the north and Larba in the south, both of whom have access to their son's children's labor, one sees in fact that they cultivate 0.7 ha and 0.2 ha, respectively. Likewise, the three young women in our southern case studies cultivated on average 0.3 ha while the only young woman amongst the northern case studies cultivated 1.4 ha.

In chapter 7 we have seen that indeed women in the north have much higher agricultural receipts than women in the south. For example, if we take women of comparable life cycle stages, Kilpoa and Yempousa, the southern woman has half the agricultural earnings and cultivates 0.7 hectares less than the woman from the north. Furthermore, if we look at the most well-off woman amongst our southern case studies, Aibibatou, in her middle age (i.e., above 30) who has two children below the age of eight, three children between eight and 15 years old, and is married to a well-to-do man, even she has agricultural earnings that are below both the poorest and the elderly women in our northern case studies (Podiandi, Mindiba, and Folpoa).

However, these differences that we note do not necessarily imply that southern women will follow the same path as those in the north. The fact that the southern village has a nearby, semi-urban, consumer population, may influence production and consumption behavior to be different in the southern village. Already we have seen in chapter 7 that off-farm activities such as petty trade, tend to be more important for women in the south than for women in the north.

What do these changes in women's roles in agriculture mean for their use of networks? And does the difference between the two villages in terms of women's involvement in agriculture result in differences in how they use their networks? The increasing presence of markets in villagers' daily lives and women's rising need for money are trends associated in some gender literature with the decline of women's networks. Hemmings-Grapihan (1985) studying women's changing social and productive roles in a Gourmantché village only 20 km north of the northern research village, argued that women's networks with their natal families have declined if not disappeared. This, she argues, happened with the greater importance of market transactions making goods previously obtained through women's kinship ties now obtainable through the market. Women's relations with their natal families thus became of lesser economic importance. Another reason for the diminishing ties of women with their natal families, she argues, is that their greater involvement in agriculture takes away the time women have available to maintain relations with their natal families.

Moore (1996), studying Endo women in Kenya, also argues that commercialization caused the decrease of women's networks. She presents two case studies of women who adopted "modern" life-styles in which they sold their labor and paid for other peoples' labor to help them with their daily chores. This resulted in these women getting cut off from their traditional women support groups.

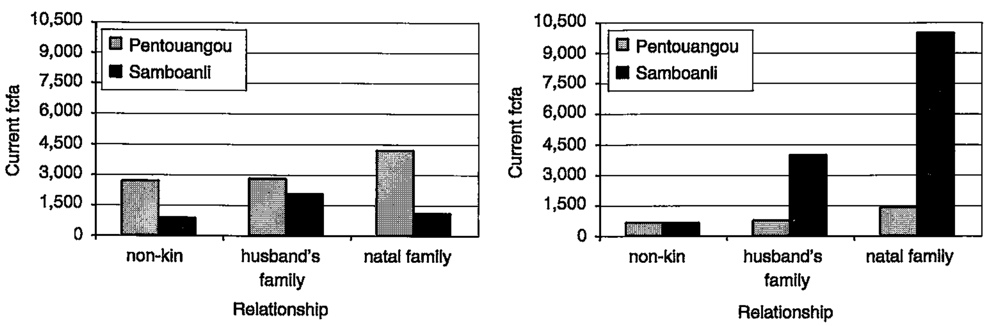
Turning to our case study women, we saw in chapter 7 that gift receiving and gift giving, one of the ways in which networks are created and maintained, are important for women. There are differences between the two villages. In the north, case study women gave more gifts and in the south, they received more gifts. And as can be seen from figure 8.1, for women in Samboanli, gifts given to the natal family and for women in Pentouangou, gifts received from natal families, were the most important in terms of value.

If we look at what was given to or received from natal families (figure 8.2), we note that gifts given and received by women consist largely of money and food, both of which can be crucial for the livelihood of the recipient. In Samboanli, there is the additional importance of gifts given for ceremonial purposes, reflecting the importance of ceremonies in the north that was discussed in chapter 7.

The pattern that Pentouangou case study women tend to receive gifts and that Samboanli case study women tend to give gifts to their natal families is a reflection of the difference in their involvement in agriculture more than a difference in importance that they accord to their natal network. As we argued above, southern women cultivate less. In chapter 7 we also saw that they earn less. They are able to cope with this lower income because a lot of the items that are paid for by women in the north, are paid by husbands in the south. However, a practice that was encountered frequently in the south is that natal families give gifts of their own agricultural production after the harvest to their daughters. This however, only happens if the daughters visit before "all gets put in the stocks", i.e., if they help with some of the harvesting. Thus natal families amongst our southern case study women help to compensate for these women's low incomes.

Tembendi is an example showing just how fundamental the help received from natal families can be. She is the case study woman who received the most gifts in the south. This is because she is living in extreme poverty due to problems she is having with her husband. He leaves her to fend for herself thus in her situation, gifts are the difference between life and death. Virtually all of the gifts she received in 1996-97 were from her natal family.

In the north instead, where the case study women were more reliant on the market and had larger incomes than in the south, women dedicated a range from 5% to as much as 37% of their total income on gifts to their natal families. As can be seen in figure 8.2, a large part of the gifts given by northern women to their natal families has to do with ceremonial gifts. However considerable money and food gifts were given that were not for ceremonial



a. average value of gifts received *b. average value of gifts given*

Figure 8.1. Average value of gifts (a) received and (b) given per woman, December 1996 to November 1997
Source: Budget diaries.

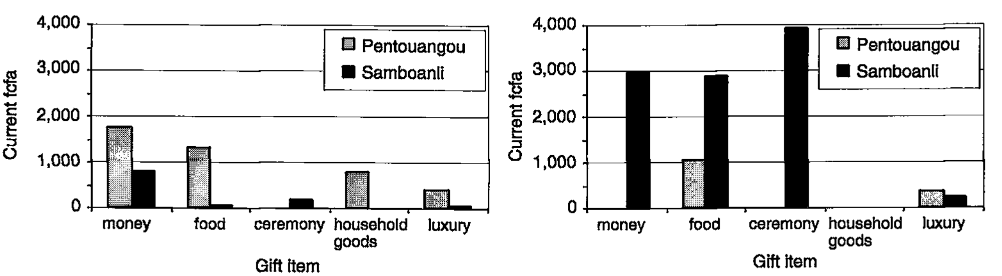
purposes. This is in contrast to the gender studies mentioned above which would foresee a lesser importance of gift giving in the north given that women derive most of their incomes through the market.

In both villages the case study women were interviewed on the specific issue of whether they had enough time to visit their natal families and if they saw this changing over time. We did not find any uniform trend of decline or increase in the time that women spent with their natal families. What came out was that, in general, women view their visits to their natal families as something desirable. Several women mentioned that they felt socially more free with their natal family. Factors such as a grinding mill in the south were influential in determining how much time women could spend with their natal families. Mill grinding substantially reduces the time women spend on meal preparation and thus frees time to visit natal families if these are close by. Also, the post-harvest gifts from natal families in the south depended largely on whether a woman was cultivating in the same area as her natal family and could thus easily reach them to help them with the harvest.

These networks with natal families have various purposes, not least of which is to help women maintain a balance of power with their husbands. Telling are the jokes that are often made to men when their wives, in case they come from another village, go visit their natal families for an extended period (ten days to two weeks during the dry season is common). The jokes relate to the wife not coming back or running off with another man. There is always laughter around these jokes but a nervous smile can sometimes be detected on the husband's face.

We now look more specifically at how these natal networks are used in agriculture. Networks can help access seed in two important ways. When a woman first marries she can begin to cultivate her own field if she has seeds available. While they receive land from the husband's lineage, all case study women received seeds with which they began cultivating their own fields, from their natal family. Natal family ties thus represent an important way for women to begin their agricultural activities.

The other way in which women's natal families help in providing seed is that they can provide a tie with people beyond the village territory. This happens when a man marries a woman from another village, which, as resulted from the exploratory village census (chapter 3), is a common practice as 54% and 44% of the women from Samboanli and Pentouangou, respectively, come from outside the village. Furthermore, the three



a. type of gifts received *b. type of gifts given*

Figure 8.2. Type of gifts (a) received and (b) given per woman to natal family, December 1996 to November 1997
Source: Budget diaries.

genealogies conducted with Bandia's, Yabre's and Djoulmani's families showed this to be a common practice also in the past. These ties are important for being able to access seed from other areas as a way to discover new landraces and also as a way to access different landraces to adjust to changing rainfall trends.[163] As noted in chapter 6, a soil and water conservation technique that farmers use is that of switching landraces of the crops they grow to those better adapted to today's lower rainfall levels. This can be done only if a sufficiently diverse number of landraces are available and accessible to a farmer. Women's natal networks provide the geographical spread necessary to make available and give access to landraces that are maintained in areas with different soils and climatic conditions. Such a diverse set of landraces would not be possible for a farmer to maintain only on his or her field.

A few examples help illustrate this phenomenon. During the 1996 agricultural season, one of the case study individuals in Samboanli was experimenting with a new variety of sorghum. His wife had noted the "beautiful white sorghum" variety in her uncle's village approximately 20 km away and told him about it when she came home. He subsequently sent a message to the uncle that he would like some seed for the following season. No payment was given for this seed, it was received as a gift. The variety was growing well in the 1996 season and the farmer planned to sow a greater quantity the following year. Another example is one of the four new sorghum varieties to be introduced within the past half century. This land race, locally called *biari* was introduced in the village around 1988 through the in-laws of one of the farmers.

The geographic expanse of women's natal ties also offers a good network for borrowing land. As was explained in section 8.3, being able to borrow land is increasingly an option for not over-cultivating one's own lineage land. Women's natal ties can be of great importance to accessing land to borrow especially if the woman comes from another village so as to be able to borrow land outside of the village territory. One man in the six households for whom field-level data was collected, was cultivating on the land of his wife's relatives.

We also noted through cultivation histories that natal ties were an important way for women to access agricultural equipment, namely plows. A plow is difficult to borrow because at the time when it is most needed, the owner of the plow will be using it. Therefore, to have a good chance of getting access to one relatively quickly, one must seek a plow within one's network. In 1996 Sambo's plow broke down during land preparation on the communal grain field. His wives were behind in tilling the soil on their own fields and were counting on the use of the plow after it was done being used on the communal grain field. To remedy the situation, the first wife was able to obtain a plow by asking a natal relative, while the second wife, through her natal family, was able to obtain a donkey. At the end of the season the women gave gifts of kola nuts to the lenders although it was not a preagreed payment.

Finally, another way that women use their relations with their natal families is to keep their livestock possessions with them. This can serve two functions. One is that spreading one's livestock amongst different geographical locations minimizes the risk of having one's

[163] Ghezai (1999) also notes the importance of women's natal ties for crop genetic diversity in Eritrea.

stock decimated by disease. The other is that natal families are a way for women to keep their resources out of reach of their husbands. What is kept with the natal family, a woman can hide from her husband. Information about this was of course, difficult to come by. Nonetheless, we know that at least two of the case study women in the northern village had livestock with their natal family. In one case it was a goat and in another a calf.

The argument made thus far about women's natal ties being used for agricultural purposes raises the question whether women, through their networks, are able to get access to the same means of soil fertility maintenance as men. Chapter 6 already suggested that this appears to be only partially the case, as women use less soil and water conservation practices on their plots (especially in terms of the use of household refuse and manure). It may therefore be expected, assuming that women do not obtain better soils than men, that soil fertility of women's plots is lower than that of men's plots. Based on the collected soil samples (chapter 3) it is possible to compare the chemical soil fertility of women's and men's plots to see whether this is indeed the case. A general linear model was used to compare village and bush fields cultivated by women and men (no soil samples were collected on women's compound fields). The results of this analysis are given in table C.8a in appendix C. From the analysis, it follows that the factor gender is insignificant for all measured fertility indicators (organic matter, nitrogen, phosphorus, and potassium). At closer inspection, a post-hoc test (table C.8b in appendix C), however, reveals a significant difference between the organic matter content of the topsoil on good sites of women's and men's plots. For total phosphorus this difference is just significant. For the other fertility indicators and for the bad sites differences were not found to be significant.

These findings can be explained by the fact that women have less access to manure than men. When cattle are paddocked this is done on the man's communal grain field. Furthermore, manure available from small stock kept within the compound also goes to a man's communal grain field. Finally, women often do not own carts nor seem to borrow them to collect manure. The above analysis suggests that this lack of access to organic matter reduces their ability to maintain soil fertility on all parts of their field at the same level as men but it does not lead to large differences in overall soil fertility between men's and women's fields.

The readiness with which women have been incorporated into agriculture reflects the household's increased need for income brought on by increased monetization, the fact that land is available, and that women do not grow tree crops which would give them permanent cultivation rights to land. However the possibilities that networks give them, also eased their entry into agriculture by providing seed as well as giving women the possibility to keep livestock in different geographical areas to reduce risk of herd decimation due to livestock disease. Furthermore, women's natal networks allow landraces and land to be accessed so as to adapt farming practices to the declining rainfall trends of the past 40 years as well as the increase in population. Agriculture has both, created the necessity to maintain women's natal networks as well as provided the means with which networks are maintained. To argue that monetization brings the demise of women's natal networks, as some gender literature does, is to only look at part of the picture. Women's greater role in agriculture, declining rainfall, and increases in population have created an increased need and new uses for women's networks.

8.6 Networking in inter-ethnic relations

The increase in livestock numbers coupled with the expansion of cultivated area experienced in much of West Africa are seen as causes of land degradation (Cleaver and Schreiber 1994). Both of these factors are influenced by the increased market integration of African societies (Blench 1997). Furthermore, it is argued that the increasing strain on natural resources brings pastoral and agricultural groups into increasing conflict as they compete for scarce resources (Benoit 1982; de Haan *et al.* 1990; Kessler and Breman 1995; Diallo 1996; van Driel 1996; Blench 1997). The research area is experiencing all of these trends: increased monetization, greater livestock population densities, and expansion of cultivated area. However, we argue in this section, similarly to what Breusers *et al.* (1998) find for the Mossi, that relationships between Gourmantché and Fulbe are not necessarily on the decline, nor marked by a deteriorating complementarity in the economic and ecological spheres.[164] To the contrary, relationships between the two groups are changing as a result of people adjusting to changes in social and natural contexts in which agriculture is practiced. It is through these adjustments that people are able to relieve the pressure on land that would otherwise be experienced.

Inter-ethnic relations are clearly changing in the southern village by virtue of the recent settlement of semi-sedentary Fulbe on the village territory. The way these relationships are being forged and maintained today in the southern village offers us a good example of how people adapt and amend their ways of networking to adjust to changing circumstances. Furthermore, the fact that Fulbe settlement in the northern village dates back to over a century offers a comparison from which much can be learned.

While inter-ethnic relations are important also amongst women, this discussion will deal with relationships between men. The reason for this is our focus on the aspect of inter-ethnic relations that affect agricultural and livestock activities which are primarily those between men. Relationships between Gourmantché and Fulbe women have various aspects to them but they predominantly affect petty trade activities and household tasks.

On the southern village territory are three neighborhoods inhabited by semi-sedentary Fulbe (Diallo 1997). Settlement of the oldest of the three groups began around 1969 but the newest of the three groups settled as recently as 1984. In the northern village instead, the oldest group of Fulbe settled in the area since "well before the arrival of the whites". The most recently arrived group settled around 1939. Fulbe thus have been settled in the north for a longer time than in the south. Furthermore, in the north, there are groups of Rimaïbè, as well as mixed households in which a Rimaïbè head of household is married with a Gourmantché woman. These inter-marriages do not exist among the population of the southern village reflecting the much more recent history of inter-ethnic relations between the Gourmantché and the Fulbe and the fact that there are no Rimaïbè.[165]

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[164] This complementarity in relationships between agriculturists and pastoralists based on mutual dependence and mutual advantage in the economic and ecological spheres is what de Haan *et al.* (1990) define as symbiosis.

[165] For the remainder of the section, we refer to Fulbe and Rimaïbè populations as Fulbe because the distinction is not relevant for the argument.

There are many disputes between Gourmantché and Fulbe in both villages but these, we argue, are balanced by a symbiotic need that the two ethnicities have for each other (Breusers *et al.* 1998). The Gourmantché need the Fulbe to herd their cattle for them. Gourmantché own an increasing number of cattle. This trend picked up momentum during the famines in the early 1970s and 1980s which hit the Fulbe harder than the Gourmantché allowing the Gourmantché to purchase much of the livestock owned by the Fulbe. Gourmantché are increasingly investing in cattle given the high market value of cattle with respect to the cost of living. At the same time, however, Gourmantché continue to farm. This means that Gourmantché do not have time to tend to cattle during the agricultural season as well as that cattle should be far from farming areas in order to limit the damage they would cause to crops. Thus Gourmantché are in need of the Fulbe pastoralists to herd their cattle for them while they tend to their agricultural and off-farm activities. Gourmantché's need for Fulbe extends also beyond the realm of livestock. Fulbe are considered important for resolving problems of human fertility. For example, if a Gourmantché woman has several miscarriages, she may be advised by the elders of her husband's family to go live near or with a Fulbe family. Often the child that is born will be given the name Foldjoa or Folpoa meaning Fulbe man or woman.

In return, the Fulbe need the Gourmantché in order to obtain food. Special relationships between the two allow the Fulbe to obtain grains at times when they are difficult to find in markets, as well as obtaining them at preferential prices. They also get to consume and or sell the milk and its by-products of the cattle they herd. More profoundly, herding cattle of Gourmantché allows Fulbe to continue a way of life, even in cases when they no longer have cattle of their own, that is fundamentally linked to their culture and identity. For semi-sedentary Fulbe who cultivate their own fields, their land use rights ultimately depend on a Gourmantché chief. Furthermore, Fulbe at times hire Gourmantché labor to plow their fields.

Thus for both groups it is necessary to maintain good relations with each other. Although Gourmantché usually provide shoes and a mat for their herder, there are no hard rules governing herding contracts. We encountered agreements ranging from giving one Yoruba plate of millet per day to the herder's family, to offering a calf to the Fulbe after a specified number of births, to providing services for free such as the fabrication of grass thatching or tailoring. Fulbe, in turn, bring a calabash or two of milk annually to their Gourmantché family and may provide services such as buying and selling cattle for Gourmantché. The fact that these gifts and favors go in both directions further highlights the symbiotic nature of relationships between Gourmantché and Fulbe.

Relationships between Gourmantché and Fulbe not only affect Gourmantché livestock activities, but also their arable farming activities.[166] Locations of fields are affected by considerations of where one is less likely to have one's field be broken into by cattle. Often a group of people will cultivate close to each other because it is easier to keep an eye on each other's fields for cattle who break in. Conversely, if one owns cattle and keeps it himself, one will try to cultivate further away from other fields in order not to risk having

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[166] For detailed case studies on how interactions between farmers and pastoralists in Benin and Burkina Faso affect the use and management of natural resources see Dangbégnon (1998).

the cattle break into other people's fields. Crop residues may be left on a field after harvest as forage for cattle so as to benefit from their manure, while others may burn residues in order to discourage cattle from coming on to the field (some farmers view cattle dung as a source of weed seeds). Considerations relating to the use of manure influences whether farmers will encourage Fulbe to stay on their fields during the dry season. In the above cases, favorable inter-ethnic relations will reduce the need to protect oneself against cattle damage to crops, crop residues will be left on the field for the cattle to graze, and manure agreements will be sought in which Fulbe herders are asked to stay with the herd on one's fields for several days up to over a month during the dry season.

Any researcher looking into livestock numbers knows what a delicate issue this can be in many African societies. The Gourmantché are no exception. Livestock, being the most preferred investment option, is the principal indicator of wealth and status. In an outwardly egalitarian society such as the Gourmantché, it is important not to let one's cattle ownership be known in detail. This is at the source of why many Gourmantché use Fulbe herders to tend their cattle. Outwardly, Gourmantché complain about the Fulbe stealing their livestock or not caring for it well and thus want to get one's own kin into the livestock tending business. However, in practice, Gourmantché still prefer to dedicate their labor and that of their kin to agricultural activities. Furthermore, cattle tended by kin would not permit the secrecy that now exists around cattle ownership. In fact, through the information we were able to get on livestock ownership and tending from case study individuals, it results that if about three or more head of cattle are owned, there will be a Fulbe herder involved. Kin may be used but only to tend a small portion of the herd. Those who have one or two head of cattle, usually have them for the purposes of fattening and reselling. In these cases, different households within a compound may take turns daily in tending the cattle by volunteering one of their young male children to look after them. During our presence in the villages, many of the complaints of crop damage that we encountered actually derived from these children not keeping a good eye out on the cattle. In the north we recorded three cases in one season of Gourmantché households' cattle (who were tended together by their children) damaging the crops twice of other Gourmantché and once of a sedentary Fulbe.

Given the great sensitivity around livestock, Gourmantché – Fulbe relations need to be based on trust. For a Gourmantché to entrust his cattle to a Fulbe herder, he needs to be assured that the Fulbe will take good care of his animals and not sell them pretending that they died. Furthermore, he wants the Fulbe to keep the number of cattle he owns secret. The Fulbe also needs to have trust in the Gourmantché that this latter will not spread bad rumors about him if an unfortunate event such as a cattle death did occur. Otherwise, the Fulbe will have difficulties finding people whose cattle he can herd. Both Gourmantché and Fulbe are very cautious in entering into such agreements and invest time and resources in getting to know each other and building the necessary trust. It is possible to say that almost all transactions between these two ethnicities are somehow related to actual or potential cattle tending relationships and aim at creating or maintaining a relationship of trust.

In the north, where Fulbe have been present on or near the village territory for over a century, relationships of trust have developed over time. An example comes from Piampo, whose father's compound was next to "their Fulbe", as they call him. Thus a Gourmantché compound was located within meters of a Fulbe compound. They had daily contact with each other. The women used the mortars and pestles of the Gourmantché women, Piampo's mother learned to make Fulbe soap from one of the Fulbe's wives, Piampo's family members all learned to speak Fulfuldé, and Piampo's father's cattle were tended by one of the Fulbe's sons. These two families grew together and although the Fulbe no longer live close to Piampo's compound and do not tend Piampo's cattle, they continue to exchange gifts every year. It was through them that Piampo found the Fulbe who is currently tending his cattle.

In the south instead, where regular relations with Fulbe are of a more recent nature, the question arises as to how relationships of trust are initiated between Gourmantché and Fulbe. As explained above, gifts and services are exchanged between the two ethnicities in both villages. However, these mainly occur once a relationship is forged and a Fulbe is tending the cattle of a Gourmantché. How then, does one begin if historical ties do not exist? One of the general observations that struck us after we had resided in both villages, was the greater frequency and general pervasiveness of Fulbe among Gourmantché compounds in the south with respect to the north. Although these visits have a series of functions ranging from neighborly relations to commerce, budget data and key informant interviews indicate that there was a common practice of Gourmantché giving loans to Fulbe. Figure 8.3 partitions all transactions according to whom they are conducted with and shows the relative importance of loans between Gourmantché and Fulbe men. While transactions with Fulbe consist of about 25% to 30% of all transactions in both villages, loans between men of the two ethnicities consist of about 53% in the south and 45% in the north, of all loans given.

This practice exists in both villages but it is greater in the south. The importance of loan giving between ethnicities in the south is all the greater if one considers that virtually all of the loans in the north were made by one case study man: the richest man of the village who, by virtue of his status, gives out in-cash and in-kind loans. The other well-to-do man amongst the northern case studies engaged minimally in loan transactions with the Fulbe

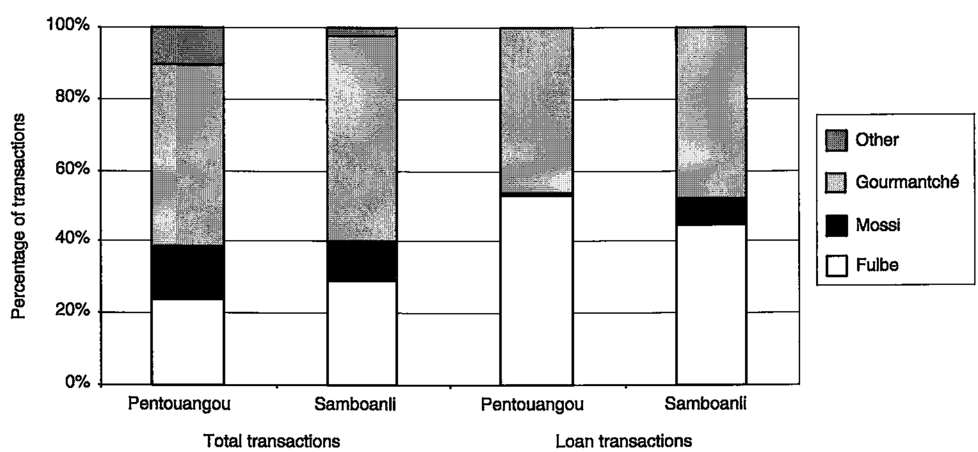

Figure 8.3. Ethnicity of transaction partners of case study men, December 1996 to November 1997
Source: Budget diaries.

despite the fact that he owns a herd of at least nine head of cattle being kept with two Fulbe herders. In the southern village, instead, all men except for the two poorest amongst the case studies were involved in lending to Fulbe, whether or not they owned cattle.

Why are loans to the Fulbe more pervasive amongst southern case study men? As was explained in section 7.6.2, monetary loans are seen as ways of establishing whether a person can be trusted. The fact that money is not perceived as an object of basic necessity, as is instead millet, makes it the object of loan requests even among people with weak or non-kinship ties. Furthermore, the fact that today many of life's necessities and luxuries can be bought with money in nearby markets, makes it an item needed by most anyone. Monetary loans thus are easy to give and easy to ask for, making them an ideal object with which to establish relationships of trust. As a respondent explained, one gives out increasingly large loans to the same person to see if he pays them back. This establishes a person's trustworthiness. The non-repayment of small monetary loans is seen as a lesser evil than the loss of cattle due to an untrustworthy herder. Once it is deemed that a Fulbe is trustworthy through renewed repaid loans, one's cattle can be entrusted to him. The budget figures show that about 40% of all loans given to Fulbe in the southern village are monetary loans while the remainder consist of food and petty trade or artisanal products.

Another practice that was found in the south but not in the north was the giving of a dead animal by a Fulbe to a Gourmantché. Fulbe do not eat their animals. If an animal would die of disease, Fulbe in the south would give the dead animals to a Gourmantché. The Gourmantché would either consume or sell the meat. This was a way that Fulbe also contributed to creating and enforcing their new relationships with the Gourmantché. In the north, instead, this practice was not encountered amongst case study individuals because the relationships between Fulbe and Gourmantché seemed to be more firmly established.

How do relationships with Fulbe impact the effects that agriculture has on the land? Numbers of livestock have increased in the research area (chapter 4). This is especially due to their rising market value. Such market incentives could easily lead to land degradation at the village or watershed level due to overgrazing. However, chapter 5 indicates that this is not the case. Fulbe pastoralists herd most cattle on transhumance routes. This allows Gourmantché to own an increasing number of cattle while at the same time reduces the pressure that would otherwise be exerted by an increasing cattle population on village territory. However, the presence of this cattle on the village territory in the period just following the harvest allows fields to be fertilized by manure. This is the time when farmers will reach agreements with pastoralists to have cattle stay on their fields. This can have quite a significant, positive effect on soil fertility, as noted in chapter 6.

Second, as we saw in chapter 7, livestock rearing (including poultry, small stock and cattle) contributes to people's total inflows. Livestock then provides an important alternative source of income other than crop production through which farmers can earn a living. This reduces the pressure on arable farming to provide for all of farmers' livelihoods. As such, farmers do not need to over-cultivate their soils to provide food for themselves and their family.

Finally, cattle ownership seems to provide the necessary security that allows farmers to invest in arable farming. Economists studying the contribution of alternative sources of income to agricultural performance look at whether the income earned from other activities is reinvested in arable farming (Reardon *et al.* 1992). The technology survey showed that most plows, carts, and animals for traction were financed through agricultural surplus production or through off-farm income. However, cultivation histories of case study individuals revealed that investments in equipment requiring a substantial outlay of money seemed to be made only if at least some cattle were owned. Of the 10 case study individuals who owned a plow, eight invested in one after having first bought between one and three cattle. Hambila owned more because he had inherited them from his father. Investments in agricultural equipment are risky because, given the fluctuations in production and the unpredictability of farmers' money needs, buying equipment may leave one, at least temporarily, without money to cover one's needs. This suggests that cattle give a sense of security that allows farmers to take the risk of investing in agricultural equipment.

These findings run counter to the literature that argues that relationships between agriculturists and pastoralists are deteriorating due to the increasing competition of resources. Increased monetization of society has led to more cattle being held by Gourmantché as well as the fact that most everyone is in need of money for their livelihoods. In this section we have seen how monetary loans have increasingly become a way in which inter-ethnic relationships can be initiated and maintained. This practice exists in both villages, but in the southern village where historical ties with semi-sedentary Fulbe do not exist as in the northern village, the practice of extending monetary loans to Fulbe is more widespread. These relationships with Fulbe allow Gourmantché to have more cattle without leading to overgrazing of their territory. The management of Gourmantché – Fulbe relationships illustrates how people have been able to avert, at least temporarily, a potentially degrading situation (overgrazing) with adjustments to their social institutions (monetary loans).

8.7 Networking as access to equipment and inputs

Although most cultivation is done uniquely with a hand hoe, other farm equipment and inputs are increasingly becoming part of the repertoire of options farmers have to choose amongst when deciding how to farm. The use of farm equipment, purchased inputs, and soil and water conservation structures, otherwise termed farm capital, is considered to be the way to intensify so as to increase productivity without damaging the environment (Ruttan and Hayami 1972; Reardon 1997). The low use of farm capital in sub-Saharan Africa is, amongst others, said to be hampered by the low incomes of African farmers (see for example, de Graaff 1996; Reardon 1997). Reardon and Vosti (1995) for example, argue the need to promote farmers' off-farm activities in order to raise their incomes to be able to invest in farm capital. While low incomes can certainly act as a deterrent to investing in farm capital, the focus of these studies is only on the accessibility of technologies through money. It is common, in fact, for analyses of agricultural surveys to categorize households as owners or non-owners of animal traction, that is, households that bought and those that did not buy animal traction equipment (Barrett *et al.* 1982; Savadogo *et al.* 1998). This section focuses on how farmers in the research area access farm capital other than by purchasing it.

We turn to the use of plows because it gives a good example of how equipment may be accessed through networks and also because the plow has been historically at the center of agricultural development interventions. Although deep tillage using animal traction can break down fragile soils and lead to erosion and accelerated burning of organic matter (Nicou and Charreau 1985), if used correctly it can instead contribute to soil and water conservation. Plowing improves water infiltration of soils and soil surface characteristics through the incorporation of vegetative material which improve the soil's protection against water and wind erosion (Nicou *et al.* 1993; Hoogmoed 1999). Furthermore, chapter 5 showed that the use of a plow is positively correlated with yields. Finally, farmers also see the positive aspects of plowing for mixing organic matter into the soil and for loosening the soils to allow for better plant growth (especially groundnuts) and better water infiltration (chapter 6).

According to a national level survey, only 3% of the agricultural population in Gnagna and Gourma provinces owns a plow (MARA 1996a). However, this wide scale survey, as well as smaller scale studies on animal traction in the area (Barrett *et al.* 1982), focus on the ownership of plows and draft animals, ignoring the possibility of borrowing them. Such an omission can lead to conclusions that underestimate the actual use of technologies in rural African agricultural practices. In following farming practices of case study individuals, we noted the frequent practice of lending and borrowing plows and draft animals as well as other equipment such as carts. Although our technology survey is not from a representative enough sample (chapter 3) to extrapolate to the whole village population with precision, it is nonetheless indicative of this phenomenon. Ownership of plow and draft animals was virtually nil for women and 40% and 50% for men, respectively (table 8.2). However, if one looks at borrowing of plows, another picture emerges.

If one considers ownership and borrowing of plows together, then table 8.2 shows that women use plows almost as much as men (61% versus 71%, respectively). In general, we see that borrowing of equipment and draft animals[167] is commonplace. We also see from table 8.2, supporting what was exposed in the section 8.5, that women are net borrowers of equipment.

Borrowing of equipment, much like the borrowing of land, does not usually entail an agreement for compensation if it happens among kin relations. Borrowing of equipment between Gourmantché and Fulbe does however, entail a salary because Fulbe also ask Gourmantché to conduct the work. Even when there is no direct payment involved, often the lender will offer something as a sign of appreciation.

By borrowing equipment, farmers are able to overcome the inflexibility of buying equipment. To purchase equipment one needs to commit a certain amount of money. If the equipment does not produce enough of a rise in income right away to make up for its costs (which, aside from the characteristics of the technology itself, is very likely given the vagaries of the natural and social environment), then the farmer incurs a loss in cash that he

[167] Women seem to underreport borrowing of draft animals. This is because many more report borrowing a plow than draft animal while their ownership of draft animals is low. It is likely, however, that women borrow most draft animals from compound members, as 63% of owners of draft animals said they lend to people within their compound, but that they do not consider it as borrowing as it is with someone in their own compound.

Table 8.2 Use of agricultural equipment in the research villages, 1996

Type of equipment	Owns (%)	Borrows (%)	Total users (%)
		Women (N = 46)	
Plow	2	59	61
Draft animal	4	30	35
Cart	0	15	15
		Men (N = 28)	
Plow	39	32	71
Draft animal	50	25	75
Cart	14	32	46

Source: Technology survey, data for married, agriculturally active adults in Gourmantché wards.

or she may need for other purposes. This, therefore, involves a risk. Farmers explained that even loans offered by the extension service for the purchase of a plow, were too inflexible because they had to pay within a pre-defined number of years. Borrowing overcomes the inflexible nature of equipment purchases for those who do not dispose of enough savings to take this risk.

It is important to note, however, that borrowing plows usually entails accessing them late as the owner of a plow will first use it on his fields. This means that to borrow one with reasonably good timing, one needs to ask people with whom one has close ties. In fact, sedentary Fulbe who usually borrow plows from Gourmantché, are often heard complaining about the difficulty it is for them to access a plow in time. This is because a kin relation takes precedence over a relationship with a Fulbe for borrowing equipment.

Another aspect of plow borrowing that needs to be noted is that numbers of people who borrow says nothing about the amount of land that is plowed. It may well be that the amount of land plowed with a borrowed plow is less than that plowed with an owned plow given that borrowed plows are accessed late. This would make an interesting research question for an agricultural survey to address.

Networks are also used to access agricultural inputs as well as the knowledge about them. In section 8.5 we have seen how ties with women's natal families offer a geographical widening of social networks that allows access to different landraces. In fact, if we look, as is done in table 8.3, at how landraces were introduced in the research villages, we see that between 40% and 50% were introduced through relationships with people such as through a local missionary, villagers who migrate for some time and then return to the village with new landraces, migrants who come to the village usually to settle there and bring landraces with them, or relations such as family or friends living in other areas. Although both government agencies and markets can also involve relationships between people, these tend to be of a more impersonal nature. We make this distinction because most extension work is done through official organizations or markets whereas these results show how important informal contact between people can be for the propagation of technologies.

Table 8.3 Provenance of recently introduced landraces (ca. 1950-1998)

	Samboanli	Pentouangou
	Provenance of recently introduced land races	
Government agencies	9	11
Markets	7	1
Relationships with people:		
Missionary	0	9
Villagers migrating out	8	1
Migrants coming to village	0	7
Relations	3	2
Do not know	0	5
Total introduced within the past 50 years	*27*	*37*
	Crops and land races currently grown	
Different types of crops currently grown	21	28
Total number of landraces currently grown	85	84

Source: Fieldwork.

Other landraces are introduced through government agencies such as the national extension service or OFNACER that distributed grains after famine years.[168] Markets are also a means through which landraces are discovered. Piampo's account of how he discovered a new cowpea landrace can illustrate how markets act as a means through which new landraces are accessed. Piampo was visiting a market located far from Samboanli. He noticed a man who was selling just harvested cowpeas. This was surprising to him as his cowpeas were still maturing. He asked the man about the landrace and how he cultivated it and bought a small quantity to try out on his field next season. This landrace comprises half of the total cowpeas that he now plants in his fields. Since then, he says, the variety has been cultivated by other farmers in the village.

It is also interesting to note the difference that one individual can make. In this case it was a French missionary in Fada N'Gourma in 1960 who was working on his own to promote horticultural crops. Through him, nine landraces were introduced into Pentouangou.[169] The other differences between the two villages, are landraces brought by returning migrants and by new settlers. This reflects the fact that migration is a more widespread phenomenon in the north (chapter 4) and that Pentouangou, instead, is in an area characterized by new settlements.

Thus we have seen that both equipment and inputs are accessed through people's networks: equipment through borrowing and inputs through gifts and the transfer of knowledge. This means that focussing only on ownership of farm capital and on access

[168] Although, as we will see in the following section, government agents can be part of villagers' social networks, they can also be little known to villagers given infrequent visits, the turn-over of government personnel, and the temporary nature of the contact such as when OFNACER distributed grains after famine years.

[169] Horticultural crops are the main difference between the types of crops introduced in the two villages. While in Samboanli mainly new landraces of already known crops were introduced, in Pentouangou new crops were introduced, mainly horticultural, of which only one landrace is available.

through monetary means or official organizations misses a large part of the dynamics behind equipment and input use. As was argued in chapter 6, having landraces to adapt to a changing climate and microniches is a form of soil and water conservation. The diverse number of landraces available to people is in part dependent on their networks. Additionally, farmers' limited incomes have been repeatedly identified as a major impediment to the use of farm capital and therefore the productivity and environmental sustainability of African agricultural systems (Reardon 1997). Furthermore, agricultural equipment entails an inflexible commitment of money. Through the use of networks, farmers are able partially to overcome both the income constraint as well as the inflexibility of the investment required for the use of equipment and inputs.

8.8 Self-help groups as access to cash

The fact that cash has increasingly become a form of payment for daily necessities as well as a form of gift giving (chapter 7) creates the need for individuals to obtain cash. Large costs such as ceremonies or medical care can create sudden large cash needs. Self-help groups that pool money together are a type of network that has developed within the past half century as a way to deal with the sudden cash needs that individuals face. However, this form of networking has developed more extensively in the northern village than in the southern village. We will argue in this section that the source for the difference in this development is due to the differences in experiences between the two villages with agricultural interventions.

Section 7.5 showed that gifts given by case study individuals are often in the form of cash and that half of the cash gifts made are given for ceremonies. Another cash component to ceremonies that has not yet been looked at is the costs of paying for ceremonies. For example, in burial and funeral ceremonies, livestock needed for sacrificing may be purchased; the cloth in which to wrap the body tends to be purchased rather than woven from one's own cotton harvest as was done in the past; and dancers and singers necessary for the ceremonies (plate XVII) are also paid in cash. Table 8.4 looks at the costs of funeral ceremonies incurred by some northern case study individuals. Funeral costs are reported because there were enough funerals documented in order to give a sense of the range of costs that these ceremonies can entail for the individual[170] and also because they are ceremonies for which costs can be captured in one year of data collection as opposed to marriage costs which range over the courtship period that can last several years.

As can be seen from table 8.4, costs of funeral ceremonies can vary considerably depending on the person who died and the relationship between the person paying and the deceased. While it is possible that some of the costs of funerals were left out from the budget diaries, it is nonetheless visible that at times these ceremonies can consist of a considerable portion of a person's total yearly receipts.

Table 8.4 also shows that a large part of ceremonial costs are paid in cash. These costs can be so large that they are outside the possibilities of individuals who are expected to pay.

[170] The figures in table 8.4 are not the total costs of the ceremony because there are many more contributors than just a husband and wife. Here the emphasis is on the costs that these ceremonies entail for an individual.

Table 8.4 Funeral costs for case study individuals, December 1996 to November 1997

Funeral of:	Husband: Total costs (fcfa)	Husband: Proportion paid in cash (%)	Husband: Proportion of total receipts (%)	Wife: Total costs (fcfa)	Wife: Proportion paid in cash (%)	Wife: Proportion of total receipts (%)
Husband's elderly father	86,400	100	49	6,500	100	12
Father of 2nd wife	22,100	61	24	13,000	100	25
Mother of 2nd wife	21,200	65	8	12,200	100	22
Mother of only wife	13,500	100	8	11,300	100	20
Paternal uncle of husband	19,500	100	11	0	0	0
Maternal aunt of husband	8,800	70	30	0	0	0
Paternal uncle of 2nd wife	3,600	0	5	10,700	44	21

Source: Budget diaries.

Note: Costs that are not paid in cash are, for example, one's own millet production used for food during the ceremony or cloth woven by the person paying for the ceremony.

Not being able to have a large ceremony to honor the deceased, in the case of a deceased elderly person, can be the source of shame for a household and is to be avoided at all costs.

Funeral costs provide an example of sudden cash needs that a family may have. However, there are other sources of cash needs such as illness. We saw in chapter 7 that costs of modern medicine necessitate sudden large sums of money. These sudden needs can pressure people into having to obtain as much as they can from the land if agriculture is their only or principal source of livelihood. It can also force them into a poverty trap by obliging them to borrow large sums, running up debts, and finding themselves producing just to relieve their debts. This is the poverty trap that is said to force people into degrading land use patterns. However, forms of networking have emerged to deal with these new cash necessities in the form of self-help groups which help relieve the pressure on agriculture and avoid the poverty trap.

In self-help groups, all members contribute a periodic, predetermined quantity of cash and each member can access this pot at least once. In other parts of West Africa tontines, or rotating credit associations, have been recorded as traditional forms of savings and loans groups (Lelart 1990; van den Brink and Chavas 1991; Vodouhê 1996; Webster and Fidler 1996). However, in the research area, life histories reveal that no such traditional groups existed among the Gourmantché until 20 to 30 years ago. Now instead, it is common to find self-help groups based on kinship or religious ties in the northern village.

This form of networking is said to have its roots in rural ways of reciprocal help such as work parties (Kane 1988). However, this particular form of monetary self-help groups are very close to the organizational form through which the extension service has worked with villagers since the early 1960s, that is, the village association, or "groupement" (chapter 4). Village associations are groups of farmers who pool their labor together to work on a field in which they try things extended by the extension service. The idea behind the extension model is that the income earned from the field's production can be reinvested in agricultural equipment and inputs for the group. The extension service offers advice on cultivation techniques and methods to be applied on the association's field for everyone to see. In actuality many problems have been experienced with this system ranging from inappropriateness of the technologies extended, absenteeism of the extension agent during the rainy season, and consequently, lack of enthusiasm on the part of participating farmers. But the system of pooling together resources for the purposes of saving has been adopted and adapted.

Self-help groups are prevalent today in the northern village. These can take the form of a group of household heads from one compound cultivating a field together and pooling the proceeds from production into an "emergency" fund for when members need to resolve a family problem. The compound of two case study households in Samboanli had such a system in place. They explained the importance of such a system for saving the family's honor because when in need, compound members were not obliged to go outside the compound to search for money for their problems. They cited two examples of how the money had been used in the past: once to help finance the funeral of one of their elders, and another time to finance the trip of a compound member to fetch back the wife and children of a deceased brother in Niger. Another example of self-help groups are those that emerge around religious communities. One of our case study members contributes regularly to a fund of the local imam. This fund was recently used to build a new mosque. Another case study member contributes regularly to the local Protestant preacher's fund. They recently used the fund to help rebuild a burned-down house of one of the church members.

In the southern village instead we did not come across any membership to a self-help group among case study individuals nor among other people whom we interviewed. Although they may exist in the southern village, the impression is that they are less prevalent than in the northern village. This difference may be due to the fact that there are fewer sudden demands for cash in the south as ceremonies occupy a smaller portion of people's total outflows. However, we have argued that there are other sudden cash demands such as through illness which people in Pentouangou also incur. We saw in chapter 7 that when such a case did result in Pentouangou, the hospital costs were paid with a mixture of gifts and the use of savings.

The difference between the two villages can be explained by the more social character of the northern village (chapter 7), making it more predisposed to the adoption and adaptation of self-help groups. However, a difference in experiences with agricultural development interventions has also contributed towards making the northern village more open to self-help groups.

One of the first, most direct and daily contact with government workers that villagers had was through the rural school system (école rurale) which was instituted in the early 1960s (chapter 4). Although the system of rural schools oscillated administratively from being located under the education ministry and that concerned with agriculture, villagers associate all government employed agriculture personnel together regardless of their ministry. A rural school existed on the border of the northern village's territory from 1962 to 1993. In this school they were taught different agricultural techniques. Its vicinity made it be frequented by some of the young men of the village. They had the good fortune of having a succession of dedicated teachers which led to the general perception of the rural school as a good thing. In the south a rural school was located at about 5 km from the village. Young men began by participating but were soon disillusioned by an absentee teacher with a drinking problem.

Other experiences affect the general attitude towards development interventions in the two villages. Although the whole of the eastern region of Burkina Faso has a history of few development interventions with respect to the rest of the country, in the 1980s the northern part of the region was identified in national agricultural plans as an area with threatening land degradation problems. It therefore experienced a burgeoning of development projects run by the national agricultural service but also by local non-governmental organizations. This led to a presence of local level field agents based close to the village and with whom villagers had regular contact. In the southern village instead the only agents involved with agriculture were those of the national extension service. Furthermore, these agents were not as present as they claimed they would be, giving villagers negative impressions relating to absenteeism, unabided by promises, abandoned projects, and false information. There is a general sense of mistrust thus that reigns villagers' perceptions of agricultural development personnel. Village association fields have not worked well in the village because of this mistrust and thus have not been picked up and adapted by the villagers for their own purposes.

Thus we have seen how new forms of network building have developed in response to the new needs for cash. Being able to access cash through self-help groups helps avoid falling into the poverty trap as well as relieves the pressure on agriculture to have to provide for all of people's livelihood needs. The idea of a self-help group has been adapted from the local extension model of associations and modified and used for meeting new cash necessities. The difference in developments of self-help groups between the two villages illustrates how a positive relationship between villagers and development agents can lead to useful developments, yet in ways that may not have been the original intention of the intervention.

8.9 Conclusions: the multiple forms of intensification

Many changes have occurred in the conditions under which agriculture is practiced: increased monetization and market integration, smaller production units, dryer climate, and rising populations of humans and livestock. These changes are usually treated as harbingers of land degradation (chapter 2). Markets are seen as a stimulus to more productive agricultural systems but if prices do not reflect the scarcity of inputs, they can also stimulate land degradation. For example, if a farmer can earn profits by producing as much as possible from his land and at the same time there is no market for land, he will be inclined to over-cultivate his land without making any investments in the land. An increase in human and livestock populations have been argued to put scarce resources under stress through over-cultivating or over-grazing. Smaller production units are also more at risk of labor shortage due to illness or death of a member. A dryer climate puts people's livelihoods at risk as well as can lead to greater erosion rates such as through wind erosion due to a decline in plant growth. The question thus is how can the agricultural system under study not be exhibiting land degradation trends while experiencing many of the changes thought to be harbingers of land degradation?

We have argued in chapter 7 that increased monetization and market integration have not led to a complete overhaul of a previously existing system of exchange. Rather these changes have been incorporated into the system of exchange to form a mixed set of market and social principles that guide people's economic action. The fact that there was no evidence of land degradation found in the study area (chapter 5) means that even if institutions are not developing along the path foreseen by the intensification literature, they are not leading to an environmentally destructive system of cultivation. This chapter has argued that this has been possible through the adaptation of institutions, in this case the institution of social networks, to the changing contexts in which agriculture is practiced.

This chapter has highlighted how social networks have changed to increasingly be used to access resources for agriculture. With the increase in land that is being cultivated, borrowing of land is an option used for not over-cultivating one's own lineage land; as production units have been getting smaller, networks are increasingly used to access labor; with women's greater involvement in agriculture, their natal family ties are used to access necessary resources for conducting agriculture; as more technologies are available for cultivating, networks are used to access them; as Fulbe settle on village territories, new forms of network building are created to allow the rearing of livestock; and finally, as cash needs become greater, ways of networking to access cash are being developed.

By looking at networks as a source of access to resources, we have treated the issue of accessibility in a broader way than do most economic studies on agricultural productivity and environmental sustainability that instead focus on access of resources through monetary means. This approach leads to four important conclusions regarding the agricultural performance of an African agricultural production system. A first conclusion is that social networks are not attributes of traditional society based on objectives of reciprocity and solidarity, untouched by the forces of capitalism. Nor are they only a way of coping with risk. Rather, they have changed in their uses, composition, and means through which they are created and maintained as a result of the mixing of social considerations with market principles that is characteristic of the cultural economy (chapter 7). Social networks serve to redistribute resources such as food which insures against localized crop failures but also to access land, labor, livestock, equipment, and inputs which are used also to make monetary profits. Furthermore, the means with which networks are created and maintained have broadened to include money, making it possible to begin or maintain a relationship by giving monetary gifts or loans. Finally, monetization has restricted the breadth of networks on the one hand, by making it more difficult to receive a gift of food as surplus production can be sold for profit, but, on the other hand, it has also amplified networks by providing means with which to initiate relationships with non-kin.

A second conclusion, related to the above conclusion that networks are a changing feature of the cultural economy, is that social networks are not just surrogate institutions that develop as a result of market failures, but rather they are institutions that "make sense" within a particular cultural, economic, and physical setting. It is very difficult for farmers to make plans given that the variability that exists in the Sudano-Sahelian zone leads to production fluctuations; high incidence of malaria, meningitis, AIDS and the like, cause frequent and unforeseeable illnesses and deaths; and the greater market integration has lead to greater risk in agriculture, all of which make it very difficult for farmers to make plans, as instead is so common in our western conceptions of development. Development projects often require farmers to make prior commitments to a certain way of cultivating and of making a livelihood. Agricultural equipment, for example, often involves an inflexible commitment: once equipment is purchased it is difficult to turn it into something else if the season progresses in such a way that one cannot make good use of it and therefore a loss is incurred. As Guyer (1992: 485) points out:

> Theories of intensification depend on the assumption that farmers have an extremely fine-tuned sense of returns to labor. Given the complexity of production patterns, the variability of the weather, and the fluctuations in prices, not to mention the dramatic year-to-year lurches in farmers' money needs, any accuracy they achieve is nothing short of miraculous and certainly surpasses our current capacity to describe the cognitive processes involved.

Social networks provide the flexibility necessary in such a context. They are flexible in that they are multipurpose (this chapter) and creating and maintaining them can be done at all times and through various means (chapter 7). Building up relationships can be done during the agricultural season as well as during the dry season when people dispose of more time and more resources (with which to make gifts, participate in ceremonies, etc.). Also, a relationship can be used for various purposes such as obtaining food in times of need, land when one's own land needs to be fallowed, labor during peak labor periods, and having the possibility to own cattle (Mazzucato and Niemeijer 2000).

This flexibility is not just a "natural" attribute of social networks but is rather the result of people adjusting and adapting to the changing context in which agriculture takes place. The fact that social networks have taken on different variations even between the two research villages, further attests to the fact that people adjust to a local context. Networks allow accessing land and labor in a piecemeal fashion to adjust to climatic vagaries and fluctuations in family labor; they allow access to technologies in a temporary fashion so as to avoid making inflexible commitments of money as more technologies become available; they have eased the entrance of new actors (women and Fulbe) into agriculture by averting over-cultivation and over-grazing that these new actors could have led to; and they allow taking advantage of new possibilities in income-earning activities by giving the possibility of conducting various income-earning activities concurrently.

A third conclusion points to the fact that social networks do not necessarily detract from agricultural productivity. Rather, by reallocating slack resources amongst society, they make resources accessible in a system that would otherwise be experiencing resource constraints and as such contribute to both long-run productivity as well as environmental sustainability. Networks give access to land without having to deplete one's own lineage land; to labor and technologies that allow cultivation tasks to occur at the appropriate moments, making the difference between having a harvest and not and thus avoiding the poverty trap that is said to be a cause of degrading practices; to labor, food, and cash which give the flexibility and security not to deplete one's own land by taking the risk to move to new land; to livestock which takes off the pressure on agriculture to provide all of people's livelihoods as well as gives the security to invest in agricultural technologies; to cash without having to earn it all from agricultural production in a given year.

Finally, the research area has experienced processes of intensification through the increased use of agronomic and biological soil and water conservation practices especially those using management skills (chapter 6). Such intensification has been successful at raising yields while not causing any identifiable signs of land degradation (chapter 5). This chapter has argued that agricultural performance is affected by the social organization around production. People dispose of both technical but also social means with which to perform non-depleting agricultural practices. In the study area people have intensified the uses of social networks for agricultural purposes. Thus not only has the use of soil and water conservation measures intensified, but so has the use of institutions. This is quite different from the intensification of farm capital intended as equipment, inputs such as fertilizer or manure, and soil and water conservation structures that many contemporary studies on African agriculture focus upon (Reardon *et al.* 1996; Sanders *et al.* 1996; Reardon 1997; Clay *et al.* 1998). In the research area social networks have contributed to making the agricultural system more adaptable than intensification theories assume. This implies that studies are not well-served by theories that think in terms of "stages" along a single population density- technology intensification path.

Plate XVI. Work party for threshing millet

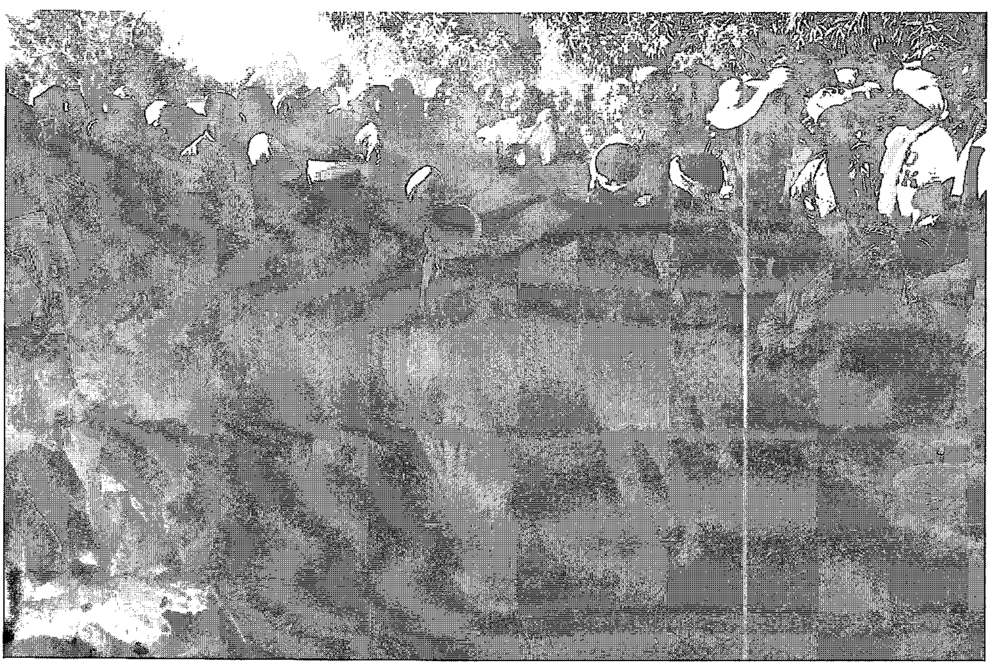

Plate XVII. Dancing at a funeral

9. Reconsidering soil and water conservation in eastern Burkina Faso

> It is always healthy to confront evidence which forces us to rethink accepted models and methods, and attempting to understand the intractabilities of African social realities may shed new light on development processes in general. (Berry 1994: 25-26)

The research area of this study is experiencing many of the trends that are considered to be harbingers of land degradation. Human and livestock populations have more than quadrupled and tripled, respectively, in the past 40 years (chapter 4). Moreover, rainfall has declined an average 300 mm since the high rainfall levels of the 1950s (chapter 5). Considering that the research area is situated in the fragile Sudano-Sahelian zone, these trends would seem to imply that natural resources are increasingly under stress. However, not only was there no evidence of land degradation taking place, but also average yields of the major staple crops have increased some 400 kg ha^{-1} over the past 40 years (chapter 5). The main question that emerges from chapter 5 is how can there be no evidence of land degradation in a system that is experiencing trends that are normally considered harbingers of land degradation?

Each of the following chapters in part 2 provides various pieces of the answer to this question. In this chapter we pull those pieces together in an attempt to explain the reasons for the lack of land degradation observed in the research area. A proof of which factors have contributed to this apparent lack of land degradation ideally requires a research design consisting of a case with and a case without land degradation. A comparison of these cases may then point out the explanatory factors. The selection of research villages was made precisely in order to have such a research design. The villages were selected according to the characteristics that are deemed to be influential in determining land degradation: strongly differing degrees of population pressure and amount of annual rainfall (chapter 3). The northern village has human and livestock population densities of 50 inh. km^{-2} and 26 TLU km^{-2}, respectively, which are very high for the fragile Sudano-Sahelian zone (chapter 4). Consequently, virtually all of the potentially usable territory in the northern village is being used for agriculture. In the south instead, population densities are much lower (13 inh. km^{-2}) and there is plenty of usable land still unexploited. Finally, the northern village receives an average of 150 mm of rain less than the southern village (chapters 4 and 5).

Again, a large difference for the Sudano-Sahelian climate where small variations in rainfall can mean the difference between having a harvest or none at all.

The villages also have some common characteristics. They are both located in a rural Sudano-Sahelian setting, where farmers are considered to follow safety-first, subsistence strategies which, according to studies that view poverty as a factor propounding land degradation (Hudson 1991; Cleaver and Schreiber 1994), provides a typical setting for finding degradation trends. Also, the villages were chosen with the same ethnic composition in order to exclude cultural factors from explaining any differences in land husbandry that we might find (chapter 3).

Despite these characteristics, the study villages not only did not exhibit land degradation, but there was no significant difference in the state of soil fertility on both cultivated and uncultivated land between them (chapter 5). This means that we cannot prove that one factor or another was fundamental in causing land degradation in one village and not in the other village. Rather, we can point to some of the possible factors that account for the lack of degradation that was found in both villages, despite their differences in terms of pressure on resources.

Given the low use of purchased inputs such as mineral fertilizers, biocides, and improved seed, this suggests that farmers have found other ways of increasing production to meet the demands of a growing population, while at the same time maintaining environmental sustainability. The observed productivity increase (chapter 5) is unlikely to be attributable to the increased use of animal traction alone, because, at present, still only 15% of the plots in the eastern region are tilled using animal traction (MARA 1996a). This suggests that there are intensification dynamics of African agricultural systems that are still not well understood.

An important contribution towards the observed environmentally sustainable productivity increase can be found in the large repertoire of soil and water conservation technologies used in the study area. In chapter 6, it was argued that Gourmantché farmers have extensive knowledge of soils and soil fertility, which they use for crop cultivation. Especially the use of agronomic/biological soil and water conservation practices was found to be widespread, and to a lesser extent the use of mechanical conservation practices (chapter 6). These practices were observed in both villages. The fact that, despite high population densities in the northern village, there was no evidence of land degradation and that soil and water conservation measures were practiced also in the low population density village, seem to indicate that farmers develop suitable methods in advance of a crisis situation.

Although the observed practices may be categorized as conservation practices, they also contribute to agricultural productivity. More intense weeding, more frequent re-sowing in case rainfall fails in the early stages of crop growth, more attention to plant spacing, thinning and gap-filling, use of more appropriate landrace mixes, fine tuning of crop sequences, and so forth, also lead to increased productivity, without requiring the cultivation of more land. It is far more difficult to establish changes in these practices, let alone quantify their contribution to productivity. Changes in a number of these practices were, however, clearly observed in the research area, most notably the increased intensity of weeding and the use of different landraces compared with the past. In addition, it was noted that farmers in the study area apply such practices in an adaptive way, so as to adjust their use to changing qualities of a soil, variations in rainfall in the course of an agricultural season, a decline in rainfall over the past 40 years, shifts in family labor that they experience at any one time, increasing monetization, smaller production units, new market opportunities, new technologies, and new actors in the production process (chapters 6 and 8). This means that farmers are continuously adjusting, fine tuning and adapting in a process of experimentation and innovation. Furthermore, their agricultural practices are not only affected by rising populations but react to an array of changing social, economic, and environmental conditions.

These dynamics are supported by a system of social organization that relieves the constraints on resources that the agricultural system would otherwise face (chapter 8). Land is accessed in such a way as to allow the fallow system to exist at higher population densities. Labor shortfalls, faced by today's smaller production unit due to life cycles and unforeseen events such as illness, are met by accessing labor through work parties. This helps to make time available for the more labor intensive agronomic/biological practices that farmers use. New landraces and equipment that allows farmers to adjust to a changing climate and shifting work schedules are accessed through social networks. Pressure is taken off of agriculture by being able to earn an income through livestock husbandry, an activity that is only possible through networks with the Fulbe. Gifts and self-help groups give access to food and cash which also serve to relieve the pressure to earn all of one's livelihood from agriculture. Furthermore, gift-giving and interest-free monetary loans have developed slightly differently in the two research villages as a result of the differences in their histories and local contexts (chapter 7).

These examples show how agricultural performance is not only based on technical knowledge but also on the ability to use social institutions that mediate access to resources. Thus people dispose of a repertoire of both social and technical ways of conserving the land.

The flexibility allowed by the system of social organization is not a "natural" attribute of a traditional system, but rather a result of people dealing with the changes in the social and environmental contexts within which agriculture takes place (chapter 8). This flexibility gives people the room to act, based on their knowledge and skills, so as to make choices that are right for the land rather than push them, as theories with "thresholds" assume, to extreme measures such as soil mining.

The fact that a fallow system was practiced widely in both villages, with such different levels of population densities and amount of land under cultivation, indicates that the fallow system is not so much a "natural" state of low population density agricultural systems, but rather a strategy that is pursued as part of adjusting one's practices to the delicate ecology of the Sudano-Sahelian zone.

Because the focus of studies on intensification has been on the use of agricultural equipment and purchased inputs, the lack of these is explained in terms of a "malfunctioning" economic system with inefficient or inexistent markets, poor transport infrastructure, imperfect information and the like. This is due to the fact that theories of technological intensification require institutions to develop and function according to capitalistic principles. However, the principles guiding the economy in the study region are neither traditional nor capitalistic, but have evolved as a mixture of market principles and social considerations within a particular historical and cultural context. This mixture of principles guiding economic action is what we called the cultural economy (chapter 7).

Combined with the previous argumentation, this suggests, that even if an economy is not developing along purely capitalistic principles, it can still lead to forms of intensification that contribute to the productivity and the environmental sustainability of an agricultural system. Neither the forms of intensification nor the institutions that support it have been adequately theorized and understood for African farming systems.

All the above mentioned points contribute to explaining how Gourmantché farmers were able to maintain a productive and environmentally sustainable production system in light of changing natural and social conditions. While this is based on two villages, in a specific region of West Africa, within a particular time period, there are reasons to argue that the dynamics here described may be experienced in other areas. Chapter 5 showed that there is insufficient evidence of widespread land degradation in Burkina Faso as a whole. Furthermore, it was noted that increased mechanization and mineral fertilizer use, even at the national level, only marginally explain the increasing yields and maintenance of land productivity under wide ranges of population densities. Also, dynamics such as the individualization of production (i.e., smaller production units) and an increasingly pervasive monetization of society are processes being experienced in many parts of West Africa (Marchal 1986; Vaugelade 1991; Berry 1995). This highlights that studies on African agricultural systems may not be well-served by guiding concepts as population densities, intensification of agricultural equipment and purchased inputs, and mutually exclusive concepts of economic systems such as traditional versus capitalistic. Rather, there is a need to understand the dynamics underlying African agricultural systems through the study of local logics and processes that can only be addressed through empirical studies, of which this study is one.

Conclusion: theorizing the dynamics of soil and water conservation

> The ideas which are here expressed ... are extremely simple and should be obvious. The difficulty lies, not in the new ideas, but in escaping from the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds. (John Maynard Keynes cited in Bohannan and Dalton 1962)

Chapter 9 brought together the different parts of the puzzle to try to explain why, for the system under study, no evidence of land degradation was found despite trends that are normally thought to be harbingers of land degradation. This chapter instead, presents the broader conclusions and implications that can be drawn from this study on a theoretical level, regarding the dynamics behind soil and water conservation in West African agricultural systems. These will be discussed in the same order in which the analytical framework was presented in chapter 2. First, the conclusions regarding land degradation are considered. This is followed by conclusions relating to the study of technologies. Third, conclusions regarding the social side of soil and water conservation are drawn. A fourth section brings the various conclusions together into one overarching conclusion about the study of soil and water conservation in African agricultural systems.

Questioning land degradation

Most studies on soil and water conservation take land degradation as given. The reasons for this, discussed in chapter 2, are related to the influence of Malthus' theory of population growth on today's debates about the environment. Malthus (1803) argued that growth in population, if left unchecked, will outpace production and therefore lead to a situation of starvation and death. Africa, with the most rapidly growing population in the world, has thus given rise to growing concern. Malthusian thinking has been applied to current day discussions about the land – population nexus (Blaikie and Brookfield 1987), leading to doomsday scenarios about the environment in which an increasing population is forced to degrade natural resources in order to make a living.

Studies forecasting crisis scenarios, however, either assume that land degradation is taking place, without trying to understand the dynamics that are occurring, or they measure land degradation in highly dubious ways. The problem is that it is extremely difficult to assess land degradation. Various studies (Blaikie 1985; Stocking 1987; Biot *et al.* 1995; Scoones and Toulmin 1998) as well as chapter 5, have outlined the inaccuracies involved with the tools, models, and methods used in measuring land degradation; the difficulty of selection of indicators to sufficiently prove that there is land degradation; the costs involved if all indicators were to be measured; the problems with upscaling analyses so as to come up with estimates of the extent of land degradation; and finally, the lack of accurate historical data to effectively contextualize the measured phenomenon: is it indeed part of a downward trend or is it just a temporary dip? Chapter 2, further argued that difficulties in measuring land degradation are not just of a technical nature. Whether land is degrading depends on the perspective taken (Blaikie and Brookfield 1987: 26). What one person may consider land degradation may not be considered so by another. A further difficulty in measuring land degradation relates to what is chosen as a reference point: land is degrading with respect to which previous state? There is a general tendency in current land degradation policy debates to vaguely consider the past as an ideal state in which social and natural environments were in harmony with each other (Peet and Watts 1996; Scoones and Toulmin 1998).

Recognizing the difficulties with measurement and the subjectivity of land degradation, we nonetheless see a utility in trying to quantitatively look at the issue in order not to fall into the trap of taking land degradation for granted. While a quantitative analysis is not a final proof of the existence or non-existence of land degradation, it can nonetheless be one of the components of an analysis investigating the dynamics behind changes observed in the environment.

The research area of this study is considered to be exhibiting worrying trends towards land degradation (e.g., INERA 1993). Yet chapter 5 questioned this land degradation narrative on its own terms through a multi-scale analysis using national and regional level statistics, as well as regional and village level soil fertility data. Both kinds of data are usually used as indicators of worsening trends. It was found that despite the decline in rainfall experienced since the wet 1950s and the increase in human and livestock populations after independence, yields have increased in the eastern region and at the national level. In order to understand what was behind the picture that was emerging, a regional and village level analysis using soil samples was conducted. No evidence was found of a decline of organic matter or any of the major soil nutrients (nitrogen, phosphorus, and potassium) since the late 1960s, nor were long-time uncultivated soils found to be more fertile than cultivated soils. Rather, it appeared that cultivated soils were in some respects more fertile than uncultivated soils, indicating the importance of land husbandry practices in explaining the lack of land degradation (chapter 5).

These findings, although not a definitive proof of the non-existence of degradation, do point to the fact that the issue is more complicated than debates about the population pressure – land degradation nexus reveal. Rather, they concur with the increasing literature arguing that what is happening to African landscapes is much more variegated than the one declining trend towards land degradation allows for (Fairhead and Leach 1996; Leach and Mearns 1996; Adams and Mortimore 1997; Afikorah-Danquah 1997; Scoones 1997; Fairhead and Leach 1998). As such, the analysis in chapter 5 points to the need to further investigate the dynamics that underlie the emerging picture.

Conclusion 1: questioning land degradation

Quantitative analyses of land degradation are useful in questioning land degradation narratives as well as point to the need to further investigate the dynamics behind African production systems.

Implication: studies on soil and water conservation need to question land degradation rather than assume it. One way to question land degradation is to critically review data on which land degradation narratives are based.

The role of technologies in land degradation – population debates

The lack of evidence of land degradation in the study region contradicts the Malthusian doomsday scenario. Despite rapid population growth in the area, production seems to have been able to keep pace in an environmentally sustainable way. One may argue that in the study region population densities have not yet reached the drastic proportions that cause a Malthusian scenario. However, the northern study village has high human and livestock population densities of 50 inh. km^{-2} and 26 TLU km^{-2}, respectively, which are on par with the provinces of the Central Plateau, known as one of the most densely populated areas in the Sudano-Sahelian ecological zone. Furthermore, as much as 65 percent of its territory is used for agriculture (chapter 5). These figures are high for the fragile Sudano-Sahelian environment and, were this agricultural system headed for a Malthusian crisis scenario, then the analysis presented in this study ranging over a century should at least show the beginnings of a worsening trend; but it did not.

A possible way to explain the lack of degradation that was found in the northern village could be through intensification theories. Esther Boserup's (1965, 1981) theory about population growth providing the impetus for technological change (chapter 2) has been recently revived in the cadre of land use studies in order to explain why Malthusian doomsday scenarios are being avoided in certain areas. In these recent studies (for example Brouwers 1993; Tiffen *et al.* 1994; Adams and Mortimore 1997) Boserup's thesis is extended to the land degradation debate by arguing that as land becomes scarce, the technological change stimulated by population growth will go in the direction of conservation technologies in order to conserve the scarce, and therefore highly valued resource: land.

Hayami and Ruttan's (1985) theory of induced innovation, which has guided much theorizing about development since its introduction in the early 1970s, provides a similar argumentation to Boserup. According to this theory, as resources used in production processes become scarce, their price will rise. This will provide the incentive for farmers to save on that resource and innovate in the direction of substituting more cheap things for the scarce and expensive resource. In this logic then, land will become more expensive and stimulate innovations such as chemical fertilizers, improved husbandry practices, better management systems, and biocides that will substitute land as a production factor and therefore lead to its conservation (chapter 2).

In fact, the northern village was found to use soil and water conservation technologies more intensively than the southern village (chapter 6). Thus population pressure does seem to have an influence on people's agricultural practices as theories of intensification foresee. However, there are some characteristics that population pressure does not explain. For example, in the southern village, despite the low population density (13 inh. km^{-2}) and the fact that only a small proportion of the territory is currently used for agriculture (chapter 5), farmers are also using soil and water conservation practices. Consequently, no difference was found in soil fertility between the two villages. Furthermore, a historical look at the use of mechanical soil and water conservation structures such as stone lines revealed that these structures were used more frequently in the past, when population pressure was much less than at present.[171] Additionally, a spatial analysis of agricultural productivity revealed no significant correlation with the wide range of provincial population densities in the country. This indicates that farmers do not wait for a crisis situation to develop before they will practice some form of soil and water conservation (chapter 9). Farmers, unlike studies that grant primacy to population pressure would predict (e.g., Vierich and Stoop 1990; Cleaver and Schreiber 1994; Bationo *et al.* 1998; Breman 1998), must be responding to more than just high population densities when practicing environmentally sustainable forms of agriculture.

Conclusion 2: farmers adjust to more than population pressure

Population pressure can act as a stimulus to the intensification of soil and water conservation technologies but it is not the only factor to which farmers respond in adjusting their practices in an environmentally sustainable way.

Implication: studies on land degradation should focus on understanding how agricultural systems respond to the various changes in the social, economic, and environmental contexts in which agriculture takes place, rather than focus singly on population pressure as an indicator of the use or non-use of soil and water conservation technologies.

The lack of land degradation found in the study area as well as rising yield trends (chapter 5) raise the question, what are the land users doing in order to avoid degrading the land despite the adverse trends of rising population and declining rainfall? Theories of intensification place the emphasis on technologies as a way to increase production in an environmentally sustainable way. Low input cultivation systems are deemed to be too slow at producing enough to feed a rapidly growing African population (Ruttan 1990; Breman 1998). The emphasis is therefore placed on farm equipment such as plows and tractors and on purchased inputs such as chemical fertilizer in conjunction with LEISA[172] methods such as mulching and tied ridging (Reardon *et al.* 1996; Sanders *et al.* 1996; Reardon 1997; Clay

[171] Stone lines are now used less than in the past because people have moved from the steeper slopes and uplands to flatter and low lying areas in response to decreasing rainfall, and consequently have less problems with soil erosion (chapter 6).
[172] LEISA stands for Low External Input Sustainable Agriculture

et al. 1998). The absence of these measures is interpreted as a lack of an appropriate intensification which will eventually, under population pressure, lead to land degradation.

In the study area, farmers make little use of machinery and purchased inputs. Even animal traction is, at present, only used on a minority of plots (chapter 9). Farmers were, however, found to make extensive use of their knowledge and management skills through the application of agronomic/biological soil and water conservation practices, as well as, to a lesser degree, mechanical conservation technologies (chapter 6). In chapter 9, it was argued that these practices not only contribute to soil fertility maintenance, but also lead to increased productivity. What is especially important, and what distinguishes the use of these practices by farmers, from similar practices applied in experimental plot studies, is that they are applied in an adaptive fashion. Through several examples, chapter 6 showed how, within the life-time of a farmer or within the cultivation cycle of a plot, or even within the course of a single year, different management practices are applied in response to rainfall dynamics, the changing fertility status of a field as a result of crop production, or fluctuations in labor availability. In addition, mechanical conservation practices, mulches, and other inputs are applied only on those portions of a plot where the farmer deems them most effective.

These observations are in agreement with authors who argue that in Africa, techniques based on investment in knowledge of crops, landraces, and management mixes and sequences can contribute much more to productivity and environmental sustainability than the simple formula of labor and capital intensification explains (Burnham 1980; Richards 1983; Dommen 1988; Guyer 1997). These authors argue that the repertoires of West African farmers make farming systems much more capable of adapting to changing population densities than population pressure models assume. For example, Richards (1983) highlights that through the system of intercropping devised by African farmers, cropping systems are productive and environmentally sustainable. Dommen (1988) maintains that crop mixes constitute one of the primary ways that African farmers intensify and create the conditions for increased input use and major innovations, if these occur. Yet other researchers have highlighted how farmers match the use of landraces to resource stress (Adesina 1992; Vôss 1992). In another publication, Richards (1993) carries the argument further and states that the social organization around production, or what he calls factors affecting performance, such as the music and beer offered at work parties, can impact productivity as might the adoption of improved landraces. Guyer (1992) suggests that work schedules can be shifted and manipulated to deal with changing social contexts while maintaining the productivity of a system.

This implies that a productive and environmentally sustainable form of intensification can have more forms than the often focused upon option of equipment and purchased input use. The fact that LEISA has been judged to produce only a minimal increase (Ruttan 1990), while the system under study has effectively outpaced population growth by raising per capita production of the major staples (millet and sorghum) with a factor 1.5 between 1971 and 1997, while the average cultivated area per capita remained stable (chapter 5), indicates that the effects of LEISA techniques on the environment and plant growth have yet to be fully understood.

Conclusion 3: alternative forms of technology intensification

Intensification obtained by some African agricultural systems is based on the knowledge of crops, soils, and the environment, as well as the management skills with which this knowledge is applied. This form of intensification has obtained higher levels of productivity and environmental sustainability than approaches advocating capital-led intensification recognize.

Implication: there is a need for farming systems studies to increase the understanding of the effects of farmers' technologies and adaptive management on agricultural productivity.

This lack of understanding of the effects of LEISA on the environment stems from the fact that farmers' adaptive management remains elusive to a scientific approach based on controlled experiments (Richards 1989). This becomes all too clear if soil fertility data from farm and village level studies (such as the present study, but see also, for instance, Prudencio 1993) are compared with measurements and estimates from, for example, erosion studies, long-term experimental plot studies, and nutrient budget studies. This mismatch in evidence implies that the methodology of these technical studies needs to be improved, especially in the way that the spatial and temporal dimensions of the problem are dealt with (chapter 5). It will also be a challenge to find ways to incorporate the effects of farmers' management practices in estimating soil loss, yield trends and nutrient budgets.

Conclusion 4: understanding the quantitative effect of management

At present, quantitative studies based on on-station trials or nutrient budget calculations are not able to explain the productivity and environmental sustainability achieved by African farmers.

Implication: quantitative studies on soil fertility and degradation need to take on the challenge of improving their methodologies to better capture on-farm reality in their measurements and models.

Social institutions and soil and water conservation

Intensification theories assume specific trajectories of institutional development in order for technological intensification to take place (chapter 2). Boserup (1965, 1981, 1987) describes societies going from "traditional" or feudal systems to becoming modern societies guided by market mechanisms and private land tenure, i.e., capitalistic principles. Hayami and Ruttan's (1985) theory of induced innovation, although used to describe different paths of institutional development, actually relies heavily on markets functioning as prescribed by neo-classical economic theory in which prices of resources adjust according to the availability of these resources; again, capitalistic principles dominate institutions. According to these theories, the evolution towards capitalistic institutions will lead to societies inventing and using technologies more intensively to conserve their scarce resource, land.

These theories exemplify the more general tendency in studies about African societies to dichotomize economies as being traditional, guided by principles of reciprocity or modern, guided by market principles (e.g., Polanyi 1944; Scott 1976; Hyden 1980). This tendency reflects in economic studies about African agricultural systems in which solutions aim at getting institutions to function according to neo-classical economic principles. Local economies are described as having fragmented labor markets, industry mobility barriers, high transactions costs, financial insecurity, and the like (e.g., de Janvry *et al.* 1991; Fafchamps 1997; Reardon 1997). That is, they are held against the blueprint of a modern economy, criticized for the discrepancies, and advised as to how to reduce and ultimately abolish these discrepancies.

In chapter 7 it was argued that the principles guiding economic action in the studied system cannot be categorized as being purely capitalistic nor traditional. Rather, a mixture is found of market principles and social considerations. Market transactions are pervasive, livelihoods are earned not only through subsistence farming but also through incomes earned with off-farm activities and livestock husbandry and people engage in profit making activities such as buying grain when it is cheap and reselling it when prices are high, or livestock fattening. At the same time social transactions such as gifts or interest-free loans form an important part of daily life. Even market transactions are characterized by the giving of gifts or discounts. These transactions aim at the creation and establishment of relationships between people which eventually contribute to creating an individual's social network. Furthermore, the historical development of market and social institutions does not indicate that the latter is being replaced by the former (chapter 7). The resulting mixture of principles that guide economic action is what we termed the cultural economy.

Conclusion 5: multiple trajectories of institutional development

> Studies are not well served by dichotomizations of institutions as traditional/modern or peasant/capitalistic because increasing market integration is filtered through a local history and culture that will result in systems with a mixture of principles guiding economic behavior.
>
> *Implication:* studies should not assume that one particular trajectory of institutional development ought to be followed, but rather the trajectory itself should be the subject of study in order to understand the dynamics behind African agricultural production systems.

The fact that institutions develop differently does not mean that they are environmentally destructive as intensification literature implies. Rather, as was argued in chapter 8, social networks have contributed to the productivity and environmental sustainability of the system through the flexibility that they provide in adapting to vagaries of the climate, changes in population densities, declining production units, changing repertoires of technologies, new actors in the production process, and increased monetization. Through networks fallows can exist at higher population densities and labor can be accessed to deal with the labor shortfalls experienced by today's smaller production units. This frees up labor to conduct soil and water conservation practices. Through networks people can access new landraces that contribute to the system of adaptive management found in chapter 6. Networks also give access to new technologies. They provide access to food, money, and the possibility to engage in livestock rearing, all of which take off pressure on the land to have to produce all of people's livelihood. Networks are also flexible in the way that they can be invested in. They can be invested in through money, or services or food and these can be paid throughout the year (chapters 7 and 8). Networks thus provide a kind of flexibility that is not met by many of the soil and water conservation measures and other agricultural technologies that are currently extended to African farmers (Mazzucato and Niemeijer 2000).

The reason why social networks can perform these functions is that they have changed over time in their uses, composition and the way that they are created and maintained. Networks are increasingly used for agricultural purposes in order to access necessary resources, they have extended to non-kin members, and they have incorporated money as a form of establishing relationships between people. Furthermore, social networks have developed in slightly different ways in the two research villages in response to differences in local contexts.

This implies that the flexibility that allows the agricultural system to adapt to changing contexts, is not an inherent quality of traditional systems characterized by social networks. Rather, social networks themselves are transformed and flexibility is a characteristic that emerges as a result of people adjusting to changes in the context in which agriculture is practiced.

Conclusion 6: social networks to deal with changing contexts

Social networks are not the unchanging characteristics of a traditional system, but rather change as a result of people dealing with changing social, economic, and environmental contexts. As such they can be fundamental to making an agricultural system productive and environmentally sustainable.

Implication: studies on African farming systems need to pay attention to the role of social networks and their change over time, in coping with change and exploiting new opportunities.

The focus of how people access resources points to the fact that a lack of degradation is not only the result of having appropriate technologies and inputs available, but also that there is a system of social organization around the land that enables people to access the necessary resources for a non-degrading form of agriculture. The fact that social networks can serve to access resources in a flexible way means that people dispose of a repertoire of both technical and social ways of conserving the land. Investments in such networks, thus, should not be seen, as is done by both anthropologists and economists alike, in terms of taking away resources from productive investments (see for example Berry 1989; Reardon and Vosti 1995).

Conclusion 7: social and technical means of conserving land

Agricultural performance is not only based on technical means but also on social institutions that mediate the access to resources.

Implication: studies on soil and water conservation have to consider both the technical and social ways in which people conserve land.

Soil and water conservation reconsidered

All of the above conclusions raise the question whether theory and practice is well served by concepts such as land degradation, population pressure, and single paths of technological intensification and institutional development. We have argued that the dynamics behind the production system under study are not just a process of capital-led intensification nor of institutions becoming purely capitalistic. Furthermore, farmers are responding to more than just population pressure to change or intensify their agricultural practices. In fact, they use a vast repertoire of both social and technical means to exploit new possibilities and adjust to climatic vagaries and a changing society. These adjustments take place within an institutional context that develops according to local histories and cultures, resulting in a variety of institutional forms that can develop. In the system under study, these dynamics have led to productivity increases that have sustained a rapidly growing population while maintaining its environmental sustainability. We agree with Boserup (1965: 118), however, that there can be cases in which populations are not able to adapt their ways rapidly enough or in the right direction, leading to environmental destruction. Thus what is needed are not theories that impose particular paths of technological or institutional development in order to achieve conditions of productivity growth and environmental sustainability but rather make these paths the subject of scientific inquiry. The analysis presented here suggests that the kinds of intensification obtained by African agricultural systems work "through logics and at interfaces that have yet to be adequately defined and theorized." (Guyer 1997: 234). There is a need thus for analytical frameworks that place these logics and interfaces central to the analysis and give equal space to both the social, as well as the technical side of African agricultural systems.

A major challenge remains the development and operationalization of such analytical frameworks. This study developed and applied such an analytical framework in which land degradation was questioned, and the way social and environmental histories mix was focused upon in order to bring out the dynamic and contrasting trends that can be present in different localities at different points in time. As a result, the single and declining trend focused upon by land degradation studies gave way to an intricate interplay of factors through which the dynamics of an African agricultural system could better be understood.

Conclusion 8: the interplay of social and environmental histories

Forms of intensification in African production systems can only be understood in terms of the dynamic interplay between social and environmental histories. Analytical frameworks that impose particular paths of technological or institutional development in order to achieve conditions of productivity growth and environmental sustainability are too simplistic to do justice to the dynamic and contrasting trends that can be present in different localities at different points in time.

Implication: soil and water conservation studies should help shift land degradation debates from being about uni-directional, declining trends to a more articulated debate about the interplay of social and natural dynamics.

Appendix A: National level data and analyses

Table A.1 Annual rainfall trends for Burkina Faso (1923-1998), Ouagadougou (1902-1998), and Fada N'Gourma (1920-1998)

Year	Burkina Faso[a] (mm)	Ouagadougou[b] (mm)	Fada N'Gourma (mm)	Year	Burkina Faso[a] (mm)	Ouagadougou[b] (mm)	Fada N'Gourma (mm)
1902		851		1933	1078	808	955
1903		775		1934	892	748	777
1904		892		1935	1074	953	840
1905		772		1936	989	806	758
1906		979		1937	869	618	768
1907		676		1938	938	795	966
1908		713		1939	994	860	771
1909		961		1940	896	856	672
1910		645		1941	860	838	730
1911		576		1942	922	823	707
1912		600		1943	998	1012	1003
1913		409		1944	788	583	570
1914		673		1945	969	733	765
1915		775		1946	907	720	784
1916		667		1947	778	497	797
1917		977		1948	891	769	898
1918		917		1949	899	926	708
1919		652		1950	940	827	858
1920		874	943[c]	1951	1096	950	1146
1921		719	658[c]	1952	1046	884	1043
1922		1000	725	1953	957	887	1098
1923	929	773	754	1954	967	949	934
1924	986	817	838	1955	995	1041	1035
1925	1000	798	879	1956	924	1104	945
1926	744	570	684	1957	1025	994	980
1927	1012	1002	939	1958	954	769	1082
1928	996	1037	883	1959	856	990	1315
1929	889	929	771[c]	1960	878	803	986
1930	968	904	1005	1961	863	706	1029
1931	923	650	797	1962	1034	1185	1071
1932	968	706	852[c]	1963	1014	659	1087

Continued on next page

Table A.1 – *Continued*

Year	Burkina Faso[a] (mm)	Ouagadougou[b] (mm)	Fada N'Gourma (mm)	Year	Burkina Faso[a] (mm)	Ouagadougou[b] (mm)	Fada N'Gourma (mm)
1964	1013	1104	1061	1982	725	635	790
1965	945	852	771	1983	626	675	668
1966	938	649	923	1984	657	571	647
1967	863	765	869	1985	799	674	766
1968	1000	774	987	1986	823	794	612
1969	946	1045	913	1987	723	785	646
1970	847	729	732	1988	813	735	765
1971	859	726	739	1989	792	798	930
1972	807	1060	840	1990	682	676	568
1973	739	746	730	1991	939	901	1012
1974	908	924	814	1992	794	699	934
1975	799	756	996	1993	783	751	893
1976	864	1106	741	1994	892	728	991
1977	732	635	894	1995	811	700	883
1978	793	764	784	1996	796	677	724
1979	825	731	908	1997	708	588	715
1980	779	593	710	1998	828	668	927
1981	765	714	785	*Mean*[d]	*886*	*795*	*854*

Sources: ADDS (1998c) and the national meteorological service.

[a]Average of 16 major stations: Banfora, Bobo-Dioulasso, Boromo, Dédougou, Diébougou, Dori, Fada N'Gourma, Gaoua, Houndé, Kaya, Koudougou, Koupéla, Léo, Ouahigouya, Tenkodogo, and Ouagadougou. For Ouagadougou an average was taken of Ouagadougou Aero, Ouagadougou Mission, and Ouagadougou Ville.

[b]Ouagadougou Mission for 1902 to 1948, Ouagadougou Ville for 1949 to 1952, and Ouagadougou Aero for 1953 to 1998.

[c]In these years at least the shown amount of rainfall was recorded, but the records are incomplete (at the beginning or end of the rainy season).

[d]Long-term average from beginning of records to 1998.

Table A.2a Provincial data for Burkina Faso on areas, population, and livestock

Province	Rainfall 1956-98 (mm)	Area (km^2)	Unprotected area (km^2)	Agricultural population 1993 (persons)	Agriculturally active population 1993 (persons)	Population 1995-97 (persons)	Livestock 1993-94 (TLU)
Bam	612	4,211	4,211	204,291	110,802	184,067	91,528
Bazèga	803	5,404	4,323	347,001	189,053	398,413	255,711
Bougouriba	948	7,200	6,088	256,875	142,337	265,504	123,530
Boulgou	830	8,537	8,469	448,852	230,853	534,465	272,986
Boulkiemdé	767	4,208	4,208	345,708	197,398	421,503	110,237
Comoé	1079	18,098	15,255	232,787	114,414	342,513	120,511
Ganzourgou	770	4,253	4,077	242,341	135,441	250,900	273,202
Gnagna	629	8,660	8,660	329,483	170,512	314,748	285,904
Gourma	780	26,159	20,671	305,535	147,682	410,529	316,780
Houet	968	16,150	14,402	471,043	265,339	866,557	197,077
Kadiogo	783	438	435	24,456	14,222	879,507	23,124
Kénédougou	1055	8,321	8,321	165,740	78,260	183,335	57,702
Kossi	794	13,354	13,354	395,608	205,507	444,467	253,220
Kouritenga	749	2,886	2,877	241,750	130,860	254,809	121,482
Mouhoun	855	10,916	8,765	348,658	192,786	377,165	213,957
Nahouri	947	3,674	2,042	108,186	56,810	134,647	51,750
Namentenga	629	6,459	6,458	227,107	120,236	229,601	174,032
Oubritenga	737	5,442	5,211	344,265	194,527	351,628	147,257
Oudalan	382	10,148	10,148	139,586	57,581	140,366	111,989
Passoré	674	3,758	3,746	234,273	125,870	242,422	78,784
Poni	1064	10,223	9,823	239,140	136,283	283,083	155,460
Sanguié	781	5,199	4,433	235,621	127,057	250,526	106,841
Sanmatenga	652	9,261	9,218	395,952	211,282	440,592	195,158
Séno	505	13,461	13,461	252,630	105,714	306,175	379,095
Sissili	888	13,310	12,633	305,567	171,032	349,987	168,806
Soum	464	12,680	12,680	218,447	101,850	247,626	200,171
Sourou	652	10,127	9,987	283,804	139,443	359,631	151,177
Tapoa	791	14,534	10,914	228,266	114,160	217,292	137,548
Yatenga	587	12,579	12,579	557,931	297,888	576,354	255,812
Zoundwéogo	804	3,648	3,333	170,784	92,567	195,230	116,947
Average	*766*						
Total		*273,298*	*250,782*	*8,301,687*	*4,377,766*	*10,453,642*	*5,147,772*

Sources: Calculations based on data from ADDS (1998a, 1998b, 1998c), the national meteorological service, MARA (1994a, 1995a, 1995b, 1996a, 1996b, 1997b, 1998), and MEE (1996).

Table A.2b Provincial data on cultivated area and crop production

Province	Cultivated area (ha)	Area cultivated with food crops (ha)	Total dry production (x 1000 kg)	Total energy production (GJ)
Bam	58,364	57,348	39,898	636,829
Bazèga	117,965	117,965	87,426	1,420,181
Bougouriba	107,963	98,774	103,591	1,538,246
Boulgou	149,773	148,982	154,999	2,519,000
Boulkiemdé	126,713	126,322	90,046	1,456,753
Comoé	100,510	87,622	116,339	1,714,180
Ganzourgou	86,224	85,745	65,183	1,051,653
Gnagna	137,390	137,390	112,997	1,848,791
Gourma	118,457	115,997	106,076	1,697,605
Houet	219,320	168,268	239,353	3,128,056
Kadiogo	5,844	5,844	4,565	74,174
Kénédougou	87,044	61,083	94,030	1,126,567
Kossi	274,293	249,968	218,571	3,236,164
Kouritenga	82,058	82,051	66,990	1,087,385
Mouhoun	201,385	159,186	167,402	2,167,035
Nahouri	28,674	28,256	27,690	449,289
Namentenga	102,416	102,361	57,388	934,153
Oubritenga	121,738	121,306	85,704	1,379,742
Oudalan	68,042	68,042	28,725	465,402
Passoré	71,038	71,027	46,934	759,373
Poni	87,232	87,081	86,661	1,417,646
Sanguié	88,940	88,054	54,775	879,177
Sanmatenga	141,826	141,534	88,270	1,428,909
Séno	100,551	100,551	55,986	905,239
Sissili	143,435	132,848	123,514	1,858,339
Soum	104,888	104,886	44,412	720,520
Sourou	123,256	121,473	94,151	1,493,275
Tapoa	103,076	98,457	90,734	1,376,124
Yatenga	171,193	171,181	110,456	1,796,172
Zoundwéogo	65,409	64,137	57,608	918,355
Total	*3,395,015*	*3,203,737*	*2,720,476*	*41,484,333*

Sources: Calculations based on data from MARA (1995b, 1996a, 1996b, 1997b, 1998), Woot-Tsuen Wu (1968) and Euroconsult (1981, 1989).

Table A.2c Provincial data on agricultural technology and extension

Province	% of tilled plots tilled: Manually (%)	% of tilled plots tilled: With animal traction (%)	Donkey plows (#)	Ox plows (#)	Use of: NPK (1000 kg)	Use of: Urea (1000 kg)	Plots with anti-erosive measures (%)	Household heads: Receiving extension (%)	Household heads: Reached by national extension (%)
Bam	69.7	30.3	4,048	2,503	111	9	17.7	57	38
Bazèga	32.8	67.0	3,615	1,417	174	32	10.3	35	25
Bougouriba	89.9	10.1	528	3,027	628	379	15.2	50	48
Boulgou	54.0	45.3	2,860	15,304	60	75	4.5	33	29
Boulkiemdé	75.7	24.3	4,908	1,764	240	54	12.8	40	33
Comoé	90.2	9.7	500	2,500	2,219	1136	7.9	29	26
Ganzourgou	47.2	50.4	2,300	4,572	77	27	12.0	43	6
Gnagna	52.1	47.9	6,471	2,192	20	32	3.2	30	24
Gourma	65.5	34.4	5,781	3,222	18	1	3.0	26	24
Houet	32.7	65.5	4,705	21,151	7,925	3,830	4.6	48	41
Kadiogo	45.7	54.2	1,712	52	0	0	2.0	32	30
Kénédougou	43.1	52.7	588	6,198	5,492	3,162	6.9	58	54
Kossi	17.2	81.5	2,864	28,351	2,730	1,306	5.5	33	31
Kouritenga	53.8	45.6	5,971	2,406	0	2	5.8	36	30
Mouhoun	41.9	57.7	2,424	12,783	3,647	1,357	7.0	45	43
Nahouri	65.3	34.7	264	2,445	13	2	7.6	23	18
Namentenga	96.8	3.2	909	177	10	9	5.2	21	8
Oubritenga	43.7	55.7	7,377	652	128	44	8.4	52	48
Oudalan	72.9	27.1		114			2.1	12	10
Passoré	62.0	38.0	6,874	313	164	29	18.9	40	31
Poni	98.3	1.7	103	363	11	7	1.1	25	24
Sanguié	96.7	3.3	637	451	73	37	12.3	34	31
Sanmatenga	67.9	32.1	4,216	625	193	48	22.8	41	25
Séno	80.7	19.3	26	58	7		8.9	17	15
Sissili	68.8	31.1	8,061	3,696	878	472	5.1	38	30
Soum	58.2	27.4	423	1,496	8	7	8.2	23	22
Sourou	34.9	65.1	1,613	4,580	244	185	7.6	29	21
Tapoa	89.5	10.5	1,738	1,773	148	12	0.7	33	30
Yatenga	47.4	52.6	10,307	3,583	542	49	16.3	41	27
Zoundwéogo	25.8	73.7	2,578	2,346	120	67	20.4	53	51
Average	*57.0*	*42.4*					*9.9*	*36*	*29*
Total			*94,401*	*13,0114*	*25,879*	*12,368*			

Source: Calculations based on data from MARA (1996a).

Table A.3 Partial matrix of Pearson Product-Moment Correlations of variables investigated in the productivity per unit area analysis

	Energy production per ha	Dry production per ha	Rainfall 1956-1998	Log(%animal tilled /%manual tilled)	% of area used for cultivation
Energy production per ha	1.000				
Dry production per ha	.998	1.000			
Rainfall 1956-1998	.901	.901	1.000		
Log(%animal tilled/%manual tilled)	.074	.071	-.102	1.000	
% Of area used for cultivation	-.069	-.053	.075	.316	1.000
Log(rural population density)	-.068	-.048	.051	.254	.874
Log(TLU density)	-.269	-.243	-.205	.247	.642
Log(plows per hectare)	.431	.442	.364	.588	.389
Log(ox plows per hectare	.637	.641	.510	.525	.191
Log(donkey plow per hectare)	-.052	-.038	-.123	.477	.387
Log(kg NPK per hectare)	.438	.419	.469	.243	-.016
Log (kg urea per hectare)	.482	.455	.489	.240	.013
% Of plots with anti-erosive measures	-.247	-.248	-.166	.125	.320
% Of household heads receiving extension	.330	.328	.360	.365	.429
% Of household heads reached by national extension service	.441	.439	.456	.282	.267

Source: Data from table A.2.

Notes: Densities are based on unprotected areas. All per hectare figures are based on cultivated area.

Table A.4 Multiple regression of energy production per hectare

R^2 = 88.1% R^2 (adjusted) = 86.7%

s = 1.168 with 30 - 4 = 26 degrees of freedom

Source	Sum of Squares	df	Mean Square	F-ratio
Regression	262.518	3	87.5062	64.2
Residual	35.447	26	1.3634	

Variable	Coefficient	s.e. of Coeffient	*t*-ratio	probability
Constant	1.41166	1.1030	1.3	.2119
Rainfall 1956-1998	0.01768	0.0013	13.8	≤ .0001
Log(%animal tilled/%manual tilled)	1.29918	0.3934	3.3	.0028
% of area used for cultivation	-0.10397	0.0348	-3.0	.0060

Source: Data from table A.2

Table A.5 Multiple regression of dry production per hectare

$R^2 = 87.3\%$ R^2 (adjusted) = 85.8%

s = 0.0703 with 30 - 4 = 26 degrees of freedom

Source	Sum of Squares	df	Mean Square	F-ratio
Regression	0.881031	3	0.293677	59.5
Residual	0.128331	26	0.004936	

Variable	Coefficient	s.e. of Coeffient	*t*-ratio	probability
Constant	0.113008	0.0664	1.7	.1006
Rainfall 1956-1998	1.026e-3	0.0001	13.3	≤ .0001
Log(%animal tilled/%manual tilled)	0.072610	0.0237	3.1	.0050
% of area used for cultivation	-5.520e-3	0.0021	-2.6	.0139

Source: Data from table A.2

Table A.6 Partial matrix of Pearson Product-Moment Correlations of variables investigated in the productivity per unit labor analysis

	Log(energy production per head)	Log(dry prod. per head)	Rainfall 1956-1998	Log(ha food per head)	Log(ha cultivated per head)	Log(%animal tilled/%manual tilled)	% of area used for cultivation
Log(energy production per head)	1.000						
Log(dry production per head)	.999	1.000					
Rainfall 1956-1998	.591	.579	1.000				
Log(ha food per head)	.682	.690	-.097	1.000			
Log(ha cultivated per head)	.682	.690	-.097	1.000	1.000		
Log(%animal tilled/%manual tilled)	.107	.105	-.102	.035	.035	1.000	
% Of area used for cultivation	-.217	-.214	.075	-.308	-.308	.316	1.000
Log(rural population density)	-.504	-.506	.051	-.699	-.699	.254	.874
Log(TLU density)	-.560	-.554	-.205	-.572	-.572	.247	.642
Log(TLU per head)	-.077	-.067	-.371	.187	.187	-.012	-.340
Log(plows per head)	.319	.314	.294	-.001	-.001	.678	.196
Log(ox plows per head)	.617	.614	.479	.216	.216	.520	.124
Log(donkey plows per head)	-.246	-.246	-.125	-.375	-.375	.531	.372
Log (kg NPK per head)	.599	.592	.453	.451	.451	.237	-.042
Log (kg urea per head)	.713	.705	.470	.617	.617	.233	-.012
% Of plots with anti-erosive measures	-.400	-.403	-.166	-.327	-.327	.125	.321
% Of household heads receiving extensions	.123	.116	.360	-.207	-.207	.365	.428
% Of household heads reached by national extension service	.328	.322	.456	-.014	-.014	.282	.266

Source: Data from table A.2.

Note: Densities are based on unprotected areas. All per head figures are based on the number of agriculturally active persons.

Table A.7 Multiple regression of energy production per agriculturally active person (corrected for cotton area)

$R^2 = 93.2\%$ R^2 (adjusted) = 92.1%

s = 0.0434 with 30 - 5 = 25 degrees of freedom

Source	Sum of Squares	df	Mean Square	F-ratio
Regression	0.640185	4	0.160046	85.1
Residual	0.047010	25	0.001880	

Variable	Coefficient	s.e. of Coeffient	*t*-ratio	probability
Constant	0.669797	0.0410	16.3	≤ .0001
Rainfall 1956-1998	6.190e-4	0.0000	12.9	≤ .0001
Log(ha food per head)	0.930241	0.0732	12.7	≤ .0001
Log(%animal tilled/%manual tilled)	0.048938	0.0148	3.3	.0028
% of area used for cultivation	-2.553e-3	0.0014	-1.9	.0736

Source: Data from table A.2

Table A.8 Multiple regression of dry production per agriculturally active person

$R^2 = 91.9\%$ R^2 (adjusted) = 90.9%

s = 0.0453 with 30 - 4 = 26 degrees of freedom

Source	Sum of Squares	df	Mean Square	F-ratio
Regression	0.601924	3	0.200641	97.9
Residual	0.053263	26	0.002049	

Variable	Coefficient	s.e. of Coeffient	*t*-ratio	probability
Constant	-0.557746	0.0390	-14.3	≤ .0001
Rainfall 1956-1998	5.867e-4	0.0000	11.8	≤ .0001
Log(ha cultivated per head)	0.962221	0.0722	13.3	≤ .0001
Log(%animal tilled/%manual tilled)	0.037580	0.0144	2.6	.0150

Source: Data from table A.2

Table A.9 Nutrient balance for Burkina Faso in 1983 according to the model of Stoorvogel and Smaling (1990) and a reconstruction of that model

Nutrient	Net balance according to Stoorvogel and Smaling (1990) (x 1000 kg)	Net balance according to the reconstruction of the model (x 1000 kg)	Deviation from original figures (%)
N	-95392	-95988	0.6
P_2O_5	-27755	-27807	0.2
K_2O	-78762	-79110	0.4

Sources: Stoorvogel and Smaling (1990) and own calculations.

Note: The observed differences between the results of the original model and its reconstruction in a spreadsheet are due to some minor inconsistencies, omissions and rounding in the description of the model, the model inputs, and the model parameters as given in Stoorvogel and Smaling (1990).

Appendix B: Regional level data and analyses

Table B.1 Total population in Burkina Faso's eastern region (1903-1996)

Year	Total population	Estimated population density[a] (inhabitants km^{-2})	Annual population growth[b] (%)
1903	150,000	3.0	-
1904	158,209	3.2	5.5
1908	171,656	3.4	2.1
1910	185,038	3.7	3.8
1919	188,000	3.8	0.2
1925	165,064	3.3	-2.1
1929	190,110	3.8	3.6
1930	189,062	3.8	-0.6
1933	191,007	3.8	0.3
1938	199,388	4.0	0.9
1943	197,424	3.9	-0.2
1944	205,314	4.1	4.0
1945	206,500	4.1	0.6
1947	212,108	4.2	1.3
1952	218,009	4.4	0.6
1956	229,500	4.6	1.3
1960	214,519	4.3	-1.7
1975	407,215	8.1	4.4
1985	682,246	13.6	5.3
1991	810,324	16.2	2.9
1996	909,299	18.2	2.3

Sources: For 1903 to 1956 archival documents: RAP.MON.03, REC.04, REC.08, RAP.POL.10, RAP.INS.19/23, RAP.INS.24, RAP.POL.29, RAP.INS.31, RAP.POL.33, RAP.POL.38, RAP.POL.45, RAP.POL.47c, RAP.POL.52c, and RAP.POL.56c. For 1960 and later: Haute-Volta (1970) and INSD (1979, 1989, 1994, 1998).

[a]To calculate population densities, the area of the eastern region was fixed at 50,000 km^2. Colonial and later reports give various estimated areas ranging from 46,800 km^2 to 51,377 km^2 (a single report even gave 67,500 km^2), but this range is more likely to reflect estimation errors than actual differences in the regional borders.

[b]Annual population growth between the years in two consecutive table rows. The accuracy of this estimate is poor when consecutive table rows cover short time spans.

Table B.2 Population and population density for the eastern region in 1996

	Population		Area			Density			
Province	Rural	Total	Total	Protected	Uncultivable	Rural	Total	Total on unprotected areas	Total on unprotected & cultivable areas
Gnagna	298,412	307,372	8,660	0	2,078	34.5	35.5	35.5	46.7
Gourma	337,705	366,959	26,159	5,488	2,584	12.9	14.0	17.8	20.3
Tapoa	234,968	234,968	14,534	3,620	n.d.[a]	16.2	16.2	21.5	>21.5[a]
Total	*871,085*	*909,299*	*49,352*	*9,108*	*>4,662*[a]	*17.7*	*18.4*	*22.6*	*>25.6*[a]

Sources: Population figures INSD (1998), provincial areas calculated from ADDS (1998b), protected areas MEE (1996) and personal communications, and cultivable areas for Gnagna and Gourma provinces CRPA de l'Est (1992).

[a]No data was available on the uncultivable area of Tapoa province.

Table B.3 Cattle population in Burkina Faso's eastern region (1910-1994)

Year	Cattle population	Estimated human population	Heads capita^{-1}	Heads km^{-2}
1910	57,062[a]	185,038	0.31	1.14
1923	31,130	188,385	0.17	0.62
1929	26,340	188,965	0.14	0.53
1969	283,000	315,123	0.90	5.66
1977	314,905	451,489	0.70	6.30
1979	356,905	500,577	0.71	7.14
1980	358,800	527,087	0.68	7.18
1981	365,950	555,001	0.66	7.32
1982	373,230	584,394	0.64	7.46
1990	652,300	777,415	0.84	13.05
1994	692,300	863,022	0.80	13.85

Sources: RAP.POL.10, RAP.INS.24, RAP.POL.29, MAE (1972, 1984), ORD de l'Est (1979, 1980), MDR (1982), INERA (1993), and MARA (1995a). Human population estimated from table B.1.

[a]It is unclear whether the relatively high figure for 1910 reflects reality. It is possible that it is based on a rougher estimate than later figures because the data were collected in an early phase of the colonial occupation of the area.

Table B.4 Areas, population, and population densities for cantons in 1933 and the departments in 1996 of Gnagna and Gourma provinces

1933				1996			
Canton	Area (km^2)	Rural population (inh.)	Rural population density[a] (inh. km^{-2})	Department	Area (km^2)	Rural population (inh.)	Rural population density[b] (inh. km^{-2})
	Today's Gnagna province				Gnagna province		
Bilanga	1,299	10,516	8.1	Bilanga	2,245	66,292	29.5
Bilanga-Yanga[c]	383	1,139	3.0	-			
Bogandé	2,675	15,486	5.8	Bogandé	1,583	53,210	33.6
Coala[d]	3,589	19,577	5.5	Koalla	1,890	32,322	17.1
-				Liptougou	1,452	31,717	21.8
Thion[e]	610	4,859	8.0	Thion	316	17,726	56.0
-				Manni	435	52,715	121.1
Piéla	865	6,608	7.6	Piéla	736	44,430	60.4
Total	*9,421*	*58,185*	*6.2*	*Total*	*8,658*	*298,412*	*34.5*
	Today's Gourma province				Gourma province		
Comin-Yanga	916	12,696	13.9	Comin-Yanga	683	25,822	37.8
Diabo	865	19,746	22.8	Diabo	712	38,575	54.2
Diapangou	331	4,811	14.5	Diapangou	453	17,953	39.6
Gayéri	5,092	4,958	1.0	Gayéri	4,970	50,484	10.2
Matiacouali	2,774	6,958	2.5	Matiacoali	4,574	35,936	7.9
Fada	5,606	10,588	1.9	Fada N'Gourma	3,277	53,639	16.4
Tibga	865	15,436	17.9	Tibga	720	24,931	34.6
Yamba	1,018	4,584	4.5	Yamba	1,425	19,828	13.9
Yondé	865	5,808	6.7	Yondé	664	19,147	28.9
Pama	3,310	3,204	1.0	Pama	7,006	15,790	2.3
Madjoari[f]	3,920	1,871	0.5	-			
Soudougui	1,985	4,020	2.0	Soudougui	1,706	35,600	20.9
Total	*27,547*	*94,680*	*3.4*	*Total*	*26,191*	*337,705*	*12.9*

Source: For 1933, population data and area of the cantons are derived from RAP.POL.33. For 1996, population data is from INSD (1998), while departmental areas were calculated from ADDS (1998a).

[a]For 1933 rural population densities equal total population densities because at the time even Fada N'Gourma was little more than a village.

[b]For 1996 the population of the two major centers Fada N'Gourma and Bogandé were excluded to calculate the rural population density for their respective departments. Total population densities in those departments are respectively 25.3 and 39.3 inh. km^{-2}.

[c]Bilanga-Yanga was later joined to Bilanga.

[d]Coala was later split into Koalla and Liptougou.

[e]Thion was later split into Thion and Mani.

[f]Madjoari was later joined to Pama.

Table B.5 Selected agricultural statistics for Burkina Faso's eastern region (1971-1997)

Year	Population (persons)	Yield: Millet ($kg\ ha^{-1}$)	Yield: Sorghum ($kg\ ha^{-1}$)	Yield: Groundnuts ($kg\ ha^{-1}$)	Yield: Maize ($kg\ ha^{-1}$)	Area: Millet (ha)	Area: Sorghum (ha)	Production: Millet (1000 kg)	Production: Sorghum (1000 kg)
1971	343,238	442	612	685	822	35,285	66,720	15,600	40,833
1972	358,222	497	660	700	830	32,817	65,462	16,310	43,204
1973	373,860	n.a.[a]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1974	390,181	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1975	407,215	n.a.	n.a.	546	n.a.	n.a.	n.a.	n.a.	n.a.
1976	428,781	530	615	674	679	63,277	91,804	33,427	56,451
1977	451,489	618	848	718	n.a.	46,909	89,619	29,852	76,039
1978	475,400	768	768	690	793	42,735	79,365	32,823	60,958
1979	500,577	615	794	410	n.a.	48,909	90,831	30,079	72,080
1980	527,087	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	27,875	34,070
1981	555,001	421	421	557	736	85,620	104,646	36,016	44,019
1982	584,394	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	615,343	596	581	n.a.	n.a.	54,869	82,303	32,684	47,836
1984	647,932	580	754	n.a.	1098	48,781	59,957	28,287	45,199
1985	682,246	745	841	739	976	85,350	100,700	63,624	84,734
1986	702,092	630	899	682	991	122,600	150,880	77,210	135,655
1987	722,515	571	744	n.a.	832	93,816	117,153	53,543	87,133
1988	743,532	683	805	503	1058	111,520	131,894	76,186	106,147
1989	765,161	683	833	613	1116	94,522	145,869	64,560	121,449
1990	787,419	514	651	705	1154	72,000	149,000	37,000	97,000
1991	810,324	602	700	539	867	98,000	170,000	59,000	119,000
1992	829,217	649	746	656	1490	104,800	177,000	68,000	132,000
1993	848,551	828	1007	881	1433	143,161	159,226	118,603	160,299
1994	868,335	804	894	921	1449	112,811	170,683	90,748	152,608
1995	888,581	872	1049	642	1127	105,542	197,434	92,068	207,172
1996	909,299	930	945	1239	1161	107,826	185,951	100,264	175,706
1997	930,500	688	785	907	923	110,430	179,280	75,948	140,775

Sources: Annual reports of the eastern ORD, annual reports of the statistical service of the Ministry of Agriculture, DSAP (1995), and MARA (1995b, 1996a, 1996b, 1997b, 1998).

[a]n.a. = no data available.

Appendix C: Village level data and analyses

Table C.1 Transition matrix of land use changes in Pentouangou between 1955 and 1987 in percentages of village territory

	Land use 1987				
Land use 1955	Cultivated & recent fallow	Fallow	Uncultivated	Burned	Total for 1955
Not interpreted	0.2	0.0	5.1	0.0	5.3
Cultivated & recent fallow	0.3	0.3	1.2	0.1	1.8
Fallow	0.1	0.3	0.6	0.0	1.0
Uncultivated	7.3	5.7	74.8	1.0	88.8
Burned	0.1	0.0	3.0	0.0	3.1
Total for 1987	8.0	6.3	84.6	1.1	100.0

Source: Aerial photo interpretation.

Note: In this transition matrix rows show land use in 1955 and columns show land use in 1987. Intersections between rows and columns show the transition of land use from the 1955 use to the 1987 use. Note that row totals represent totals for 1955 and column totals represent totals for 1987.

Table C.2 Transition matrix of land use changes in Samboanli between 1955 and 1994 in percentages of village territory

	Land use 1994			
Land use 1955	Cultivated & recent fallow	Fallow	Uncultivated	Total for 1955
Cultivated & recent fallow	11.8	2.6	7.2	21.6
Fallow	5.4	0.6	1.1	7.1
Uncultivated	36.9	8.0	26.5	71.3
Total for 1994	54.0	11.2	34.8	100.0

Source: Aerial photo interpretation.

Note: In this transition matrix rows show land use in 1955 and columns show land use in 1994. Intersections between rows and columns show the transition of land use from the 1955 use to the 1994 use. Note that row totals represent totals for 1955 and column totals represent totals for 1994.

Table C.3 Linear Model for organic matter, nitrogen, phosphorus and potassium to determine significance of the factor village

Model

Dependent variables: %OM, %N, P-total, and K-avail

Factors	Nested in	Fixed/Random	Kind	F-Denominator
Constant	-	-	-	plot
Site		Fixed	Discrete	Error
Plot	Village & Land use	Random	Discrete	Error
Soil class		Fixed	Discrete	Error
Soil texture		Fixed	Continuous	Error
Land use		Fixed	Discrete	plot
Village		Fixed	Discrete	plot
Site * Village		Fixed	Discrete	Error
Error	-	Random	-	

Results

Source of variance	df	%OM Sums of Squares	%OM Prob	%N Sums of Squares	%N Prob	P-total Sums of Squares	P-total Prob	K-avail Sums of Squares	K-avail Prob
Constant	1	1.3639	≤ .0001	218.8920	≤ .0001	565.9360	≤ .0001	457.3220	≤ .0001
Site	1	0.0861	.0349	0.1039	.0267	0.0966	.0210	0.0499	.3466
Plot	58	2.0215	.0100	1.4256	.2245	3.3526	≤ .0001	3.3557	.4376
Soil class	6	0.2073	.1013	0.1790	.1989	0.5130	.0004	1.1179	.0071
Soil texture	1	0.0295	.2102	0.0314	.2154	0.0401	.1310	0.0278	.4820
Land use	3	0.0473	.7168	0.3137	.0088	0.6245	.0186	0.5948	.0229
Village	1	0.0192	.4612	0.0049	.6575	0.0129	.6381	0.0213	.5464
Site * Village	1	0.0212	.2868	0.0412	.1568	0.0072	.5184	0.1011	.1826
Error	52	0.9539		1.0388		0.8867		2.8791	
Total	123	7.3422		5.3781		9.9595		10.5928	

Source: Fieldwork.

Table C.4a Linear Model for organic matter, nitrogen, phosphorus and potassium to determine significance of the factor land use

Model				
Dependent variables: %OM, %N, P-total, and K-avail				
Factors	Nested in	Fixed/Random	Kind	F-Denominator
Constant	-	-	-	plot
Site		Fixed	Discrete	Error
Plot	Land use	Random	Discrete	Error
Soil class		Fixed	Discrete	Error
Soil texture		Fixed	Continuous	Error
Land use		Fixed	Discrete	plot
Site * Land use		Fixed	Discrete	Error
Error	-	Random	-	

Results

	df	%OM		%N		P-total		K-avail	
Source of variance		Sums of Squares	Prob	Sums of Squares	Prob	Sums of Squares	Prob	Sums of Squares	Prob
Constant	1	1.3639	≤ .0001	218.8920	≤ .0001	565.9360	≤ .0001	457.3220	≤ .0001
Site	1	0.3102	≤ .0001	0.2993	≤ .0001	0.2587	≤ .0001	0.1192	.1387
Plot	61	2.3674	≤ .0001	1.6411	.0222	3.9538	≤ .0001	3.8159	.2678
Soil class	6	0.0477	.6418	0.0503	.7691	0.1171	.1225	0.2173	.6597
Soil texture	1	0.0002	.8964	0.0022	.7089	0.0211	.1716	0.0178	.5638
Land use	3	0.0739	.5955	0.1872	.0842	0.7037	.0180	1.0455	.0019
Site * Land use	3	0.2329	.0006	0.2049	.0076	0.2096	.0010	0.1781	.3468
Error	48	0.5361		0.7349		0.5253		2.5243	
Total	123	7.3422		5.3781		9.9595		10.5928	

Source: Fieldwork.

Table C.4b Expected cell means for the interaction of site and land use and probabilities of selected differences

Level of Site * Land use	Cell Count	Expected Cell Mean[a] %OM (%)	%N (%)	P-total (mg kg^{-1})	K-avail (mg kg^{-1})
Bush field, bad	29	1.16	0.05	122	68
Bush field, good	28	1.66	0.07	164	88
Compound field, bad	3	0.67	0.03	94	139
Compound field, good	4	2.09	0.09	269	294
Uncultivated, bad	17	1.30	0.04	101	70
Uncultivated, good	18	1.52	0.05	104	62
Village field, bad	12	1.14	0.05	204	93
Village field, good	13	1.19	0.05	244	110

Probabilities of selected differences according to the Scheffé Post Hoc Test

	%OM Probability	%N Probability	P-total Probability	K-avail Probability
Uncultivated, bad - bush field, bad	.7469	.3716	.3340	.9996
Uncultivated, bad - village field, bad	.8090	.5354	.0000	.8098
Uncultivated, bad - compound field, bad	.0097	.8729	.9839	.4251
Uncultivated, good - uncultivated, bad	.4099	.4289	.9936	.9476
Uncultivated, good - bush field, good	.8933	.0254	.0023	.5817
Uncultivated, good - village field, good	.3168	.9559	.0000	.2611
Uncultivated, good - compound field, good	.2447	.0035	.0000	.0004
Bush field, bad - village field, bad	.9994	.9999	.0002	.6263
Bush field, bad - compound field, bad	.0388	.3390	.5544	.3758
Bush field, good - bush field, bad	.0122	.0264	.0553	.7358
Bush field, good - village field, good	.0482	.1108	.0103	.8489
Bush field, good - compound field, good	.5736	.5215	.0308	.0135
Village field, bad - compound field, bad	.0804	.3996	.0041	.8335
Village field, good - village field, bad	.9913	.9958	.5445	.9392
Village field, good - compound field, good	.0351	.0511	.9626	.1218
Compound field, good - compound field, bad	.0001	.0019	.0002	.4901

Source: Fieldwork.

[a]To make results easier to interpret the log-transformations used during the analysis were inverted again (10^x) to show the expected cell means of the fertility indicators in their original units.

Table C.5 Consumption of case study households, December 1996 to November 1997

Household	Name household head	Total dietary needs[a] (kg hh^{-1} yr^{-1})	Total consumed (kg hh^{-1} yr^{-1})	Surplus as proportion of needs (%)
S1A	Bandia	1781	2245	26
S2B	Hambila	6958	9277	33
S2C	Yabre	3166	2085	-34
S3D	Piampo	3100	3695	19
S3E	Konkoari	1715	2071	21
P1A	Djoulmani	1880	1795	-4
P1B	Noaga	1748	1876	7
P2C	Sambo	1945	2285	17
P2D	Babrile	1847	1373	-26
P3E	Ahandi	2473	2825	14

Source: Budget diaries and stock survey.

[a]Respondents' estimates of how many Yoruba plates their household consumes per day, converted to Yoruba plates per consumer, averaged over all households and converted to kg. An adult male was estimated as 1.0, adult women, elderly, and children between 8-15 as 0.8 and children 2-8 as 0.5.

Table C.6 Agricultural work parties organized by Gourmantché in Samboanli and Pentouangou, 1996

	Samboanli (N = 34) (%)	Pentouangou (N = 22) (%)
	Type of activity	
Field clearing	0	5
Tilling	0	5
Weeding	79	59
Harvesting	12	14
Threshing	6	14
Winnowing	3	5
	Duration	
Half day	53	50
Whole day	44	50
More than one day	3	0
	Type of field	
Village	53	14
Bush	15	36
Camp	32	50
	Average number of work parties per household	
	1.6	1.4

Source: Village survey.

Table C.7 Provenance of work party participants for Gourmantché work parties in Samboanli and Pentouangou, 1996

Village	N[a]	Provenance of participants			
		Camp (%)	Ward (%)	Village (%)	Outside village (%)
		Village field			
Samboanli	259	17	82	1	0
Pentouangou	51	67	27	6	0
		Bush field			
Samboanli	68	18	63	15	4
Pentouangou	144	0	10	36	54[b]
		Camp field			
Samboanli	147	70	22	7	0
Pentouangou	145	76	14	10	1

Source: Village survey.

[a]Total number of work party participants.

[b]The large number of people from outside the village is due to "marriage" work parties in which the suitor comes from outside the village.

Table C.8a Linear Model for organic matter, nitrogen, phosphorus and potassium to determine significance of the factor gender

Model

Dependent variables: %OM, %N, P-total, and K-avail

Factors	Nested in	Fixed/Random	Kind	F-Denominator
Constant	-	-	-	plot
Site		Fixed	Discrete	Error
Plot	Land use & Gender	Random	Discrete	Error
Soil class		Fixed	Discrete	Error
Soil texture		Fixed	Continuous	Error
Land use		Fixed	Discrete	plot
Gender		Fixed	Discrete	plot
Site * Gender		Fixed	Discrete	Error
Error	-	Random	-	

Results

	df	%OM		%N		P-total		K-avail	
Source of variance		Sums of Squares	Prob	Sums of Squares	Prob	Sums of Squares	Prob	Sums of Squares	Prob
Constant	1	0.0003	.9241	116.1340	≤ .0001	279.8570	≤ .0001	232.7850	≤ .0001
Site	1	0.0338	.0965	0.0114	.3951	0.1485	.0126	0.0143	.6557
Plot	30	0.8926	.0104	0.7145	.1371	1.7099	.0069	1.8352	.6413
Soil class	4	0.0507	.3687	0.0391	.6359	0.5550	.0009	0.5345	.1452
Soil texture	1	0.0326	.1023	0.0148	.3336	0.0498	.1302	0.0024	.8550
Land use	1	0.0043	.7068	0.0105	.5122	0.2594	.0412	0.1447	.1345
Gender	1	0.0599	.1662	0.0073	.5839	0.1252	.1487	0.1375	.1443
Site * Gender	1	0.0389	.0761	0.0288	.1816	0.0076	.5464	0.2041	.1021
Error	22	0.2468		0.3330		0.4428		1.5426	
Total	61	2.2417		1.6385		6.1492		5.9414	

Source: Fieldwork.

Note: Rare soils were excluded; compound fields were excluded because no samples were collected on women's compound fields; bottomland plots (local soil class *baagu*) were excluded because these were only cultivated by men.

Table C.8b Expected cell means for the interaction of site and gender and probabilities of selected differences

Level of Site * Gender	Cell Count	Expected Cell Mean[a] %OM (%)	%N (%)	P-total (mg kg^{-1})	K-avail (mg kg^{-1})
Female, bad	15	0.87	0.04	103	79
Female, good	14	0.96	0.04	157	68
Male, bad	17	0.91	0.04	126	77
Male, good	16	1.30	0.05	214	119

Probabilities of selected differences according to the Scheffé Post Hoc Test

	%OM Probability	%N Probability	P-total Probability	K-avail Probability
uncultivated, bad - bush field, bad	.6087	.6740	.1348	.9244
compound field, good - compound field, bad	.0105	.1889	.0435	.0516

Source: Fieldwork.

Note: Rare soils were excluded; compound fields were excluded because no samples were collected on women's compound fields; bottomland plots (local soil class *baagu*) were excluded because these were only cultivated by men.

[a]To make results easier to interpret the log-transformations used during the analysis were inverted again (10^x) to show the expected cell means of the fertility indicators in their original units.

Glossary

agronomic/biological practice: Soil and water conservation practices that make use of agronomic skills and biological material rather than physical structures.

bush camp: A bush camp (Fr. campement de culture) consists of one or more bush compounds that are used as a residence near the fields during the growing season. In some cases one or more of the bush compounds becomes a permanent residence for its inhabitants.

bush compound: A bush compound (Fr. concession au campement) is a compound that is set up near one's bush fields. These compounds are usually only lived in during the cropping season, but may in some cases eventually become a permanent residence.

bush field: Bush fields (Fr. champ de brousse) produce the bulk of the agricultural production and are therefore too large and also too far away to manage with the same intensity as the compound or village fields. Cultivation is generally for some 5 to 10 years after which the field is reverted to fallow for 10 to 50 years. Bush fields can be located at a distance of up to 10 kilometers from the village center.

bush camp fields: Bush camp fields (Fr. champ de campement) are bush fields that are near a bush compound that forms the rainy season base of (a part of) a household. No daily trips back and forth to the village are required, allowing more time to be spend on actual cultivation.

bush compound fields: Bush compound fields (Fr. champ de case au campement) are the fields immediately surrounding the bush compound. They are comparable to other bush fields in terms of their management, but as household refuse and crop processing residue are dumped on some spots in the vicinity of the compound, these spots gradually increase in fertility. While never achieving the level of fertility of the compound fields found in the village, such spots are nonetheless used to grow a little maize.

communal grain field: A type of field on which the grain is grown to meet a household's consumption needs. This field and its management is the responsibility of the household head.

compound: A compound (Fr. concession) consists of one or more huts grouped in a more or less circular form and enclosed by a wall of earth, bricks, straw mats, or stalks. This compound is shared by one or more households as their place of residence. Each compound has a compound head.

compound field: Compound fields (Fr. champ de case) are intensively managed and used for fertility demanding crops such as maize or for crops that one wants to have within easy reach such as okra. The compound fields may receive household refuse, crop processing residues, and manure collected from livestock kept inside or near the compound.

eastern region: The area of eastern Burkina Faso made up of the Gourma, Gnagna, and Tapoa provinces (according to the 1984 administrative division). After a new administrative division in 1996, Gourma province was subdivided in a Komondjari, Gourma, Kompienga, and Koulpelogo province (the latter also covering a few departments that used to belong to the Boulgou province).

embedded case study: An embedded cases study is a case study that is also part of a larger case study. For example, if case study research is done at both household and individual levels, each household is a case study and each household member makes up an embedded case study.

Fulbe: Fulbe (Fr. Peul or Peuhl, English also Fulani) are a minority ethnic group in Burkina Faso's eastern region. They live as a minority throughout West Africa and in some areas form a majority. Their principal occupation is livestock herding.

Gourmantché: Gourmantché form the main ethnic group living in Burkina Faso's eastern region. Their principal occupation is arable farming.

grounded theory methodology: A methodology first developed by Glaser and Strauss (1967) in reaction to the standard research procedure of testing hypotheses derived from the work of few theorists. Its basic premise is that theory should emerge from what is being observed. The method entails collecting information and constantly comparing it with previous information until the theoretical properties of categories are generated.

household: A household generally consists of one or more married men each with their wives and children. In some cases there are additional members in the form of other relatives (e.g., father, mother, aunt, confided children) or friends. The members of the household share the same food. Each household has a household head.

mechanical practice: Soil and water conservation practices that involve physical structures, often with a barrier function.

Mossi: Mossi are the largest ethnic group of Burkina Faso, but form a majority in most of the eastern region. Their principal occupation is arable farming.

Rimaïbè: Rimaïbè are former captives of the Fulbe. They are found throughout West Africa under various names. In the eastern region they form a minority. Their principal occupation is a mixture of livestock herding and arable farming.

rural school: Rural schools (Fr. écoles rurales, Centres de Formation des Jeunes Agriculteurs after 1974) were first created in 1961 and in some cases used until 1992. The objective of these schools, located in rural settings, was to provide children in the age of 13 to 14 years with a number of years of schooling in French and modern agricultural practices.

village: A village is made up of one or more wards and usually consists of a few hundred to a few thousand inhabitants. Each village that is officially recognized by the traditional authorities has a village chief. If the village is also recognized by the state authorities it will have a representative (Fr. délégué administratif).

village association: Village associations (Fr. groupement villageois) through which the national extension service and other development projects work with farmers.

village field: Village fields (Fr. champ de village) are larger than compound fields and are managed much less intensively. They are cultivated for long consecutive periods (10 to 20 years).

ward: A ward (Fr. quartier) is made up of one or more compounds. Each ward has a ward chief.

work party: A work party (Fr. invitation de culture) is when a person invites members of his or her extended family, friends, and neighbors to help with a task specific to the cultivation of his or her field. These tasks can be any from clearing a field, tilling the soil, harvesting and threshing. In return for people's labor the person offers food and/or drinks. These work or labor parties can take between half a day to one day. Labor parties may also be organized for non-agricultural activities such as the construction of a new bush compound.

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N.B. COR.AFD miscellaneous correspondence; DOS.CON = files of the "conseils de notables"; DOS.PAL = tribunal files; DOS.TBX = tribunal files; RAP.DIV = miscellaneous report; RAP.INS = report of inspection mission; RAP.MON = monographic report; RAP.POL = political or annual report; RAP.TOA = field report; RAP.TOC = field report of Commandant de Cercle; RAP.TRI = trimestrial report; REC = census.

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Summary

Soil and water conservation is at the top of development agendas in Africa. Virtually every project related to agriculture or the environment has a soil and water conservation component to it and environmental protection plans are being drawn up by African governments in which soil and water conservation figures dominantly. This focus on soil and water conservation is due to its being perceived as a way to address both productivity and environmental sustainability questions. Land degradation and population growth are thought to be rampant in Africa and soil and water conservation helps to increase productivity to feed a growing population and does so in an environmentally sustainable way.

Three broad approaches characterize how soil and water should be conserved. The first is a focus on capital-led intensification in the form of machinery and purchased inputs (such as mineral fertilizer and pesticides). This school of thought claims that this is the only way to obtain a fast enough increase in productivity to feed the growing population. The second approach instead focuses on "indigenous technologies", or what farmers develop, adapt, and innovate on their own account. This school claims that technologies will only be used if they are developed by and with farmers so as to take into consideration their social and environmental contexts. There is also what is called the neo-liberal approach in which it is argued that it is not enough to look at technologies, but also policies, infrastructure and markets need to be in place to stimulate the appropriate kinds of land husbandry practices.

Despite these variegated approaches, soil and water conservation projects have, at best, had a checkered history. There is a need thus to look at the problem in a different manner than is done by studies that have lead to the above approaches. This study picks up this challenge and tries to theorize and operationalize a different approach to the study of soil and water conservation. It uses elements from previous studies but integrates them in a new way. In part 1 of the book approach, analytical framework and methods are discussed, while part 2 consists of a case study in Burkina Faso (former Upper Volta) in which the proposed approach is put into practice.

Chapter 1 describes this approach which is based on three elements: (1) working in an interdisciplinary fashion to allow the integration of different aspects of soil and water conservation, (2) using a grounded theory methodology in which the principal element relates to starting out broad and allowing the concepts and principles to be studied to emerge from fieldwork, and (3) giving particular attention to developing a mutual relationship of trust with villagers in order to allow their opinions and views to influence the focus of the study.

Chapter 2 presents the analytical framework that emerged out of the grounded theory methodology. It is an end-product of the research but, nonetheless, figures at the beginning of the book, as a guide to the analysis in part 2. It is presented by discussing the most influential theories that have affected the study of soil and water conservation, followed by

an explanation of which elements of these theories have been used in the analytical framework. Malthus and Boserup have had a strong impact on how the land degradation problem is perceived. Both of their theories place the emphasis on population pressure as either a cause or a remedy to land degradation. Because Africa has been experiencing such strong population growth rates since the 1960s, these theories have been particularly influential in placing the emphasis on soil and water conservation technologies as a remedy to an otherwise serious land degradation problem. Neo-Malthusians argue that without outside intervention in soil and water conservation, there will be widespread death and degradation. Neo-Boserupians, instead, explain that once population pressure increases to above certain thresholds, it will act as a stimulus for populations to intensify agriculture and therefore develop better land husbandry practices. Here too, outside intervention can help stimulate this process of intensification.

The framework resulting from this study instead, influenced by political ecology, indigenous knowledge, and social anthropological approaches, argues that the dynamics behind African agricultural systems are much more variegated than a single trend towards land degradation allows. The framework questions land degradation narratives and, rather than focus on population density as the harbinger or cure to land degradation, it focuses on the interactions of social and environmental histories of an area in order understand the dynamic landscapes that emerge as a consequence thereof. Part 2 of the book operationalizes this approach by paying attention to social historical processes that took place in the research area within the past century (chapter 4), focusing on long-term environmental change (chapter 5), looking at farmers' soil and water conservation technologies (chapter 6), understanding local economic concepts that influence allocative decisions in agriculture (chapter 7), and how social institutions, and their change over time, affect agriculture in the study region (chapter 8). The last chapter of part 2 pulls the different parts of the analysis together to explain how, in a region that is experiencing all of the trends thought to be harbingers of land degradation, no evidence of land degradation is found (chapter 9). The contents of each of these chapters will be discussed in detail below.

The approach used in this study requires a wide variety of methods because different aspects of soil and water conservation need to be studied and because the emphasis on allowing the relevant research concepts to emerge from fieldwork requires starting out in a broad fashion. Chapter 3 presents the methods used in this study and explains the reasoning why these methods were used.

Part 2 of the book presents the chapters that aim at answering the three main research questions: (1) what evidence is there of land degradation? (2) how do people go about conserving soil and water? (3) why do people conserve soil and water in the way that they do? Chapter 4 introduces the research area and villages and focuses on the social history of the area since the late nineteenth century. The study takes place in two villages in the eastern region of Burkina Faso and focuses on the Gourmantché system of agriculture. The emphasis on historical changes experienced in this system allows the analyses of the following chapters to be placed within a broader historical picture. Some of the major changes experienced within the last century that have significantly altered the livelihood system are an increased individualization of production and consumption in conjunction with a decline of traditional authorities, increasing cultivation in bush camps, more extensive livestock ownership among the Gourmantché, and an increased monetization and market orientation. These changes have been spurred, among others, by oppressive colonial practices and increased market integration. At the same time, population and livestock densities have risen steeply, raising the question how this has influenced the state of natural resources.

Chapter 5 picks up on this question and conducts a multi-scale analysis of the indicators and proxies that are normally used to argue the presence of land degradation trends. Crop yields, agricultural productivity, biodiversity, and soil fertility are analyzed both spatially and temporally at the national, regional, and village levels. No evidence is found to support the land degradation narrative. Furthermore, the chapter highlights some of the weaknesses inherent in the methods used to analyze land degradation. Given the lack of evidence of land degradation, the strong population growth experienced over the last 40 years, and the relatively high rural population densities found in large parts of the country, the chapter excludes Neo-Malthusian predictions of widespread degradation and starvation. In agreement with Boserupian thinking, the evidence put forward in this chapter suggests that some form of agricultural intensification is instead taking place that allows food production to grow along with population. However, contrary to Boserup's theory, there seems to be little evidence that this form of intensification is based on high use of external inputs and increased mechanization. Neither are there any indications that certain population thresholds need to be surpassed before farmers undertake intensification or improve the environmental sustainability of their land use practices. How this intensification takes place and in what form is the topic of the chapters that follow.

Chapter 6, takes an indigenous knowledge approach to the study of farmers' soil and water conservation technologies, but focuses not only on descriptions of the technologies as is common in indigenous knowledge studies, but also looks at farmers' theories of soil formation and degradation processes and their own roles within these processes as users of the land. It is found that Gourmantché farmers make use of an extensive repertoire of soil and water conservation practices, most of which are agronomic/biological practices that make use of management skills and biological material. Mechanical practices that make use of physical structures are used, but to a limited extent, and they seem to have declined compared to some 30 to 40 years ago. It is argued, based on stories of informants and an analysis of aerial photographs, that this is not an indication of a decline of "traditional" practices, but an adaptation of their use to changing environmental conditions.

One of the most important points raised in this chapter is that Gourmantché farmers adapt their management practices sequentially in the course of a single growing season, as well as during the cultivation cycle of a field. This process of adaptive management has allowed farmers to maintain soil fertility or even improve it on cultivated fields relative to uncultivated land. Adaptive management involves strategic thinking and experimentation, as well as responses to changing soil fertility and unpredictable environmental and socio-economic production constraints. Thus adaptive management is a dynamic process of experimentation, fine-tuning and exploration of new opportunities.

As was argued in the analytical framework, an absence of land degradation is not only a sign that appropriate technologies and inputs are being used in a cultivation system, but also that there is a social organization around the land that allows resources necessary for an environmentally sustainable form of agriculture to be accessed. Chapter 7 analyzes the concepts that guide economic action in order to then, in chapter 8, be able to analyze how these concepts influence access to resources for agriculture. Chapter 7 analyzes the local economy by making no a priori assumptions about the type of economy, traditional or market, that guides allocative decisions. Instead, the chapter explores the concepts guiding local economic reasoning. It was found that these concepts cannot be categorized as either purely capitalistic nor traditional. Rather, a mixture is found of market principles and social considerations. Market transactions are pervasive and livelihoods are earned not only through subsistence farming but also through incomes earned with off-farm activities and livestock husbandry. People also engage in profit making activities such as buying grain when it is cheap and reselling it when prices are high, or livestock fattening. At the same time social transactions such as gifts or interest-free loans form an important part of daily life. Even market transactions are characterized by the giving of gifts or discounts. Together, these transactions aim at a delicate balance between earning profits and establishing and maintaining social networks. An analysis of the historical development of market and social institutions does not indicate that the latter are being replaced by the former. The resulting mixture of principles that guide economic action is what we term the cultural economy.

Chapter 8 looks at how the mixture of social and market principles affect the way in which agriculture is practiced, and in specific, how they influence the way land is conserved. The chapter highlights how social networks have changed to increasingly be used to access resources for agriculture. With the increased use of land for cultivation, borrowing of land is an option used for not over-cultivating one's own lineage land; as production units have been getting smaller, networks are increasingly used to access labor; with women's greater involvement in agriculture, their natal family ties are used to access necessary resources for conducting agriculture; as more technologies are available for cultivating, networks are used to access them; as Fulbe settle on village territories, new forms of network building are created to allow the rearing of livestock; and finally, as cash needs become greater, ways of networking to access cash are being developed. By looking at networks as a source of access to resources, the issue of accessibility is treated in a broader way than most studies on agricultural productivity and environmental sustainability that instead focus on access of resources through monetary means.

The various analyses of the chapters 4 through 8 are drawn together in chapter 9 to explain the lack of land degradation found in the study region while the final chapter of the book draws the conclusions from this case study to a theoretical level. The most important conclusions relating to the study of soil and water conservation are (1) land degradation narratives need to be questioned by analyzing the data on which they are based; (2) while population densities can act as a stimulus to technological intensification, farmers respond to more than just population densities in order to change their agricultural practices. It is therefore necessary to study how populations adapt to changes in the social, economic and physical contexts; (3) technological intensification obtained by some African agricultural systems is based on the knowledge of crops, soils and the environment and the management skills with which this knowledge is applied. This form of intensification has obtained higher levels of productivity and environmental sustainability than approaches advocating capital-led intensification recognize; (4) there is a need for improved scientific methods for understanding the effects of farmers' practices on the environment and agricultural productivity; (5) institutional development that takes on other than capitalistic forms, can, contrary to the assumptions made by studies of capital-led intensification, lead to productive and environmentally sustainable agricultural practices; (6) social networks are not the unchanging characteristics of a traditional system but rather change as a result of people dealing with changing social, economic, and environmental contexts. As such they can be fundamental to making an agricultural system productive and environmentally sustainable; (7) people dispose of both technical as well as social means to affect agricultural performance; (8) forms of intensification in African production systems can only be understood in terms of the dynamic interplay between social and environmental histories. Consequently, there is a need for analytical frameworks that focus on this interplay between social and environmental contexts, rather than assume a simple trend towards increasing land degradation. This kind of approach reveals the dynamic and contrasting trends that can be present in different localities at different points in time. This study offers an example of such an analytical framework and how it can be operationalized, leading to innovative perspectives on African land use systems.

Résumé

Sur le continent africain, la conservation des eaux et des sols est l'une des priorités du développement. Quasiment tous les projets liés à l'agriculture ou à l'environnement lui consacrent un volet. C'est également l'une des préoccupations majeures des programmes de protection de l'environnement actuellement lancés par les gouvernements africains. Cet intérêt est lié au fait que la conservation des eaux et des sols est vue comme solution aux problèmes de productivité et de préservation de l'environnement. Dans un continent où sévissent la dégradation des sols et la croissance démographique, la conservation des eaux et des sols permet d'augmenter la productivité afin de nourrir une population toujours plus nombreuse, tout en préservant l'environnement.

Il existe trois différentes manières d'appréhender la problématique de la conservation des eaux et des sols. La première prône le développement d'une agriculture intensive, par le biais du capital fermier sous forme de machinerie et d'intrants agricoles achetés (par exemple les engrais chimique et les pesticides). Cette école prétend que cette approche est la seule manière d'obtenir une croissance suffisante de productivité pour nourrir une population grandissante. La seconde se concentre sur les technologies autochtones, c'est-à-dire ce que les paysans développent et adaptent de leur propre initiative, ainsi que leurs innovations. Les partisans de cette approche prétendent que les technologies ne seront utilisées que si elles sont mises en place par et avec les paysans, afin de prendre en compte le contexte social et environnemental. Il existe enfin une école néo-libérale estimant que l'approche technologique n'est pas suffisante et qu'il faut également prendre en compte les politiques, les infrastructures et les besoins du marché, afin de stimuler une gestion des terres adéquate.

Malgré ces différentes approches, les projets de conservation des eaux et des sols ont, au mieux, connu des hauts et des bas. Le besoin d'une nouvelle manière de considérer le problème, différente de celles qui ont abouti aux approches décrites ci-dessus, est donc perceptible. Cette étude relève le défi et tente de théoriser et de rendre opérationnelle une nouvelle façon d'aborder la problématique de la conservation des eaux et des sols. Elle reprend des éléments d'études précédentes, mais les réutilise afin d'aboutir à une approche nouvelle. Dans la première partie du livre, figurent l'approche, la grille d'analyse et les méthodes, tandis que dans la seconde partie, est présente un cas d'étude au Burkina Faso, où est appliquée cette nouvelle approche.

Le premier chapitre est consacré à la description de cette approche, basée sur trois éléments: (1) une approche interdisciplinaire permettant l'intégration des différents aspects de la conservation des eaux et des sols, (2) une méthodologie "grounded theory", dont l'élément principal est une approche large de la problématique, afin de permettre aux concepts et principes qui doivent être étudiés d'émerger du travail sur le terrain, et, (3) une

attention particulière accordée au développement d'une relation de confiance mutuelle avec les paysans afin que leurs opinions influencent le champ de l'étude.

Le second chapitre présente la grille d'analyse issue de la méthodologie choisie. Bien que cette grille constitue le résultat de l'étude, elle figure néanmoins au début de l'ouvrage afin de servir de guide à l'analyse figurant en seconde partie. Ce chapitre présente les théories ayant le plus affecté l'étude de la conservation des eaux et des sols, suivies par une explication des éléments de celles-ci utilisés pour construire la grille d'analyse. Malthus et Boserup ont profondément modifié notre perception de la problématique de la dégradation des sols. Ils mettent tous deux en avant la pression démographique, perçue soit comme une cause soit comme un remède à cette dégradation. En raison d'une croissance démographique très forte depuis le début des années 60, ces théories ont souligné l'importance des technologies de conservation des eaux et des sols pour lutter contre la dégradation de l'environnement. Les néo-malthusiens redoutent que faute d'intervention extérieure, la dégradation des sols et une hausse du taux de mortalité soient inéluctables. Les néo-bosérupiens, eux, expliquent qu'arrivées à un certain stade de développement démographique, les populations seront obligées d'intensifier l'agriculture et, par conséquent, développeront de meilleures pratiques agricoles. Ici aussi, l'intervention extérieure est envisagée comme un stimulus pour l'intensification.

La grille d'analyse proposée par cette étude, influencée par les approches de l'écologie politique, les savoirs paysans, et l'anthropologie, avance que les dynamiques des systèmes agricoles africains sont beaucoup plus diversifiées que les théories centrées sur une seule tendance, a savoir l'augmentation de la dégradation de la terre, ne le laissent entendre. Elle met en cause les allégations concernant la dégradation des sols. Plutôt que concentrer sur la densité démographique, soit entant que signe précurseur ou remède, elle s'intéresse aux interactions entre les histoires sociales et environnementales d'une zone, afin d'en comprendre la dynamique.

La seconde partie du livre rend cette approche opérationnelle en s'intéressant aux processus socio-historiques survenus dans la zone étudiée depuis un siècle (chapitre 4); en observant les modifications environnementales à long terme (chapitre 5); en étudiant les techniques paysannes de conservation des eaux et des sols (chapitre 6); en prenant en compte les concepts économiques locaux qui influencent la répartition des ressources (chapitre 7); et en examinant l'influence des institutions sociales et de leur évolution sur la gestion de l'agriculture dans la zone (chapitre 8). Le dernier chapitre de la seconde partie synthétise tous ces éléments afin de tenter d'expliquer comment, dans une région connaissant tous les facteurs reconnus comme des signes précurseurs de dégradation des sols, il n'existe pas de phénomène de dégradation de l'environnement (chapitre 9). Le contenu de chaque chapitre est résume ci-dessous.

L'approche utilisée dans cette étude a requis un grand nombre de méthodes en raison de la multiplicité des aspects de la conservation des eaux et des sols devant être étudiés. Mais aussi parce qu'une approche initiale large était nécessaire pour permettre aux concepts pertinents d'émerger du travail sur le terrain. Le chapitre 3 présente ces méthodes et explique pourquoi elles ont été choisies.

C'est dans la seconde partie du livre que l'on trouve les tentatives de réponses aux trois questions principales de l'étude: (1) peut-on observer un phénomène de dégradation de l'environnement? (2) comment les paysans conservent-ils les eaux et les sols? (3) pourquoi conservent-ils les eaux et les sols de cette manière? Le chapitre 4 présente les villages de la zone étudiée et s'intéresse principalement à l'histoire sociale de la région de la fin du 19° siècle à nos jours. Les deux villages sont situés dans l'est du Burkina Faso, où cette recherche a particulièrement étudié le système d'agriculture gourmantché. L'importance accordée aux changements historiques survenus dans ce système permet de resituer les chapitres suivants dans une large perspective historique. Des évolutions majeures au cours du dernier siècle ont profondément altéré le système de vie: une individualisation croissante de la production et la consommation, conjuguée à un déclin des autorités traditionnelles; une augmentation de la culture dans campements de culture; un nombre croissant de bétail parmi les Gourmantchés; une monétisation accrue et une production de plus en plus axée vers une économie de marché. La colonisation et ses pratiques coercitives, ainsi qu'une intégration croissante à l'économie de marché sont entre autres à l'origine de ces évolutions. Simultanément, la densité démographique et le nombre de têtes de bétail ont connu un essor important, ce qui pose la question suivante: comment tout ceci a-t-il influencé l'état des ressources naturelles de la zone ?

Le chapitre 5 tente de répondre à cette question et analyse à plusieurs niveaux les indicateurs généralement utilisés pour démontrer les phénomènes de dégradation de l'environnement. Les rendements agricoles, la productivité agricole, la biodiversité et la fertilité des sols sont analysés de manière spatiale et temporelle, aux niveaux national, régional et villageois. On n'y décèle aucune preuve d'un éventuel processus de dégradation de l'environnement. De plus, le chapitre met en évidence certaines faiblesses inhérentes aux méthodes utilisées pour analyser la dégradation de l'environnement. Etant donné le manque de preuves concernant cette dégradation, la croissance démographique très forte de ces 40 dernières années et les densités relativement élevées des populations rurales, le chapitre exclut les prédictions néo-malthusiennes de famine aggravée et de dégradation des sols généralisée. En accord avec l'école bosérupienne, le chapitre avance des preuves suggérant qu'une certaine forme d'intensification de l'agriculture a lieu, qui permet à la production de croître parallèlement à la population. Cependant, contrairement à ce qu'affirme la théorie bosérupienne, il ne semble pas que cette intensification soit due à un usage intensif d'entrants externes ou à une mécanisation accrue. Il n'y a pas non plus de signe démontrant qu'un certain seuil de population doive nécessairement être atteint pour que les paysans se lancent dans l'intensification ou améliorent leurs pratiques agricoles afin de préserver l'environnement. La nature et la forme de cette intensification sont abordées dans les chapitres suivants.

Le chapitre 6 adopte une approche de « savoirs paysans » pour étudier les techniques paysannes de conservation des eaux et des sols. Il ne s'intéresse pas seulement aux descriptions de ces techniques, comme c'est souvent le cas dans les études consacrées aux connaissances paysannes, mais analyse également les théories des paysans concernant la formation et la dégradation des sols, ainsi que leurs rôles en tant qu'utilisateurs des terres. On y découvre que les paysans ont un vaste répertoire de techniques de conservation des eaux et des sols. La plupart sont agronomiques/biologiques et nécessitent du matériel biologique et des compétences en gestion. Les pratiques mécaniques utilisant des structures physiques sont toujours à l'ordre du jour, mais leur utilisation est plus limitée, et elles semblent être moins utilisées qu'il y a 30 à 40 ans. Se basant sur des témoignages locaux et l'observation de photographies aériennes, le chapitre soutient que ceci n'est pas un déclin des pratiques "traditionnelles", mais plutôt une adaptation de ces pratiques à un environnement en perpétuel changement.

L'un des points les plus importants abordés dans ce chapitre est que au fur et à mesure que la saison agricole avance, les paysans gourmantchés adaptent leur pratiques de gestion des terres, et procèdent de la même manière pendant le cycle de culture d'un champ. Ce procédé de gestion adaptée a permis aux paysans de préserver la fertilité des sols, voire de l'améliorer sur les surfaces cultivées par rapport aux surfaces non-cultivées. Cette gestion adaptée requiert une réflexion stratégique et sous-entend des expérimentations. Elle nécessite aussi une adaptation permanente à la fertilité évolutive des sols, ainsi qu'aux imprévisibles contraintes socio-économiques et environnementales de production. Ainsi, la gestion adaptée est un procédé dynamique d'expérimentation, de réglage permanent et d'exploration de nouvelles opportunités.

Comme démontré dans la grille d'analyse, l'absence de dégradation de l'environnement indique que non seulement les techniques et entrants adéquats sont utilisés dans le système de culture, mais aussi qu'il existe une organisation sociale autour de la terre, permettant l'accès aux ressources nécessaires pour préserver l'environnement. Le chapitre 7 analyse les concepts menant l'action économique afin d'étudier, dans le chapitre 8, comment ces concepts influencent l'accès aux ressources nécessaires à l'agriculture. Le chapitre 7 analyse l'économie locale sans aucun a priori sur le genre de cette économie, traditionnelle ou de marché, qui guide les décisions sur l'allocation des ressources. Le chapitre insiste plutôt sur les concepts guidant le raisonnement économique local. Il est observé que ces concepts ne peuvent être considérés comme purement capitalistes ou purement traditionnels. Ce sont plutôt un mélange de considérations sociales et de prise en compte des règles du marché. Les transactions de marche sont répandues et les moyens d'existence comprennent non seulement l'agriculture de subsistance mais aussi les activités non-agricoles et d'élevage. Les populations font également du profit en spéculant sur les graines ou en engraissant du bétail. Simultanément, des transactions sociales comme des cadeaux ou des prêts sans intérêt sont partie intégrante de la vie quotidienne. Les transactions commerciales sont également caractérisées par des cadeaux ou des réductions de prix. Ces pratiques ont un objectif: établir un équilibre délicat entre le gain de profits d'une part, et l'établissement et le maintien de liens sociaux, ou réseaux, d'autre part. Une analyse du développement des institutions commerciales et sociales n'indique pas que ces dernières soient en train d'être remplacées par les premières. L'amalgame de tous ces principes guidant l'action économique forment ce que nous appelons l'économie culturelle.

Le chapitre 8 montre comment l'amalgame des principes sociaux et des principes de marché affecte la pratique de l'agriculture, et plus particulièrement, comment cela influence la préservation des terres. Le chapitre met en avant comment les liens sociaux sont de plus en plus utilisés pour permettre l'accès aux ressources nécessaires à l'agriculture. L'utilisation de plus en plus intensive des sols pour les cultures fait que l'emprunt de terres est désormais utilisé pour ne pas "sur-utiliser" ses propres terres. Avec des unités de production de plus en plus réduites, les réseaux sociaux sont de plus en plus utilisés pour accéder à la main d'œuvre. L'implication grandissante des femmes dans l'agriculture entraîne une utilisation de leurs liens avec leurs familles d'origine pour accéder aux ressources nécessaires pour cultiver. Alors qu'il y a de plus en plus de technologies disponibles pour la culture, les réseaux sont utilisés pour avoir accès à ces technologies. Avec la sédentarisation des Peuls sur les territoires villageois, de nouvelles formes de réseaux prennent place pour permettre l'élevage du bétail. Et enfin, de nouvelles formes de réseaux sont créées pour répondre au besoin grandissant d'argent. En envisageant ces réseaux comme un point d'accès aux ressources, la problématique de l'accès est traitée de manière plus large que dans la plupart des études portant sur la productivité agricole et la préservation de l'environnement, en général plutôt axées sur l'accès aux ressources à travers les moyens financiers.

Les différentes analyses des chapitres 4 à 8 sont rassemblées dans le chapitre 9 afin d'expliquer la non-dégradation de l'environnement dans la région étudiée. Le dernier chapitre tire les conclusions de l'étude, à un niveau théorique. Les plus importantes de ces conclusions concernant la conservation des eaux et des sols sont : (1) les allégations concernant dégradation de l'environnement doivent être remis en question en analysant les données sur lesquelles ils sont basés; (2) la densité démographique stimule l'intensification technologique, mais ce n'est pas seulement pour cette raison que les paysans changent leurs pratiques agricoles. Il est donc nécessaire d'étudier comment les populations s'adaptent aux changements sociaux, économiques et environnementales; (3) l'intensification technologique obtenue dans certains systèmes agricoles africains est basée sur la connaissance des variétés, des sols et de l'environnement, ainsi que des compétences de gestion avec lesquelles ces connaissances sont utilisées. Cette forme d'intensification a obtenu des meilleurs taux de productivité et une meilleure préservation de l'environnement que ne le prétendent les avocats des approches mettant en avant une intensification due à l'introduction de capital; (4) une amélioration des méthodes scientifiques est nécessaire pour comprendre les conséquences des pratiques agricoles des paysans sur l'environnement et la productivité agricole; (5) contrairement à ce que prétendent les études sur l'intensification liée à l'introduction de capital, le développement institutionnel prenant des formes autres que capitalistes peut déboucher sur des pratiques agricoles productives et viables pour l'environnement; (6) les réseaux sociaux ne sont pas des caractéristiques inchangées de systèmes traditionnels, mais plutôt le résultat des populations faisant face aux changements dans les contextes social, économique et environnemental. Ainsi, ces réseaux peuvent être fondamentaux pour rendre le système agricole productif et viable pour l'environnement; (7) les populations disposent de moyens techniques et sociales pour influer sur la performance agricole; (8) les formes que revêt l'intensification dans les systèmes de production africains peuvent seulement être comprises si l'on envisage l'interaction des histoires sociale et environnementale. Par conséquent des grilles analytiques sont nécessaires pour mettre au point cette interaction, au lieu de présumer une simple tendance à une augmentation de la dégradation des sols. Ce type d'approche rend d'ailleurs justice aux tendances dynamiques et contrastées qui peuvent émerger à différents endroits et à différents moments. Cette étude est un exemple d'une telle grille analytique et de son application, démontrant comment une telle approche aboutit a des perspectives nouvelles sur les systèmes africains d'utilisation des terres.

Samenvatting

Bodem- en waterconservering staan hoog op de ontwikkelingsagenda voor Afrika. Vrijwel elk ontwikkelingsproject dat georiënteerd is op landbouw of milieu bevat een bodem- en waterconserveringscomponent. In de door Afrikaanse overheden uitgewerkte milieuactieplannen nemen bodem- en waterconservering een belangrijke plaats in. Deze aandacht voor bodem- en waterconservering is het gevolg van het feit dat de conservering van bodem en water gezien wordt als een mogelijkheid om zowel vraagstukken van productiviteit als duurzaamheid aan te pakken. Hierbij wordt verondersteld dat landdegradatie en bevolkingsgroei ernstige vormen hebben aangenomen en dat de conservering van bodem en water kan bijdragen aan een milieuvriendelijke toename van de productiviteit om de groeiende bevolking te voeden.

Er zijn drie algemene scholen die aangeven hoe bodem en water geconserveerd zouden kunnen worden. Bij de eerste school ligt de nadruk op kapitaalgedreven intensivering in de vorm van machines en aangekochte productiemiddelen (zoals kunstmest en pesticiden). Deze school stelt dat dit de enige manier is om de productiviteit snel genoeg te laten toenemen om de groeiende bevolking te kunnen voeden. De tweede school concentreert zich daarentegen op lokale technologieën, namelijk op datgene wat boeren zelfstandig ontwikkelen, aanpassen en innoveren. Deze school stelt dat technologieën alleen gebruikt zullen worden als ze ontwikkeld zijn door en met de boeren en daardoor aansluiten op de sociale en natuurlijke context. Tenslotte is er ook nog de zogenaamde neoliberale school waarin gesteld wordt dat het niet genoeg is om alleen naar technologieën te kijken, maar dat ook beleid, infrastructuur en markten beschikbaar moeten zijn om duurzame landbouwpraktijken te stimuleren.

Ondanks deze verscheidenheid aan benaderingen hebben bodem- en waterconserveringsprojecten op zijn best een wisselende staat van dienst. Er is dus een noodzaak het probleem vanuit een andere invalshoek te bezien. De voorliggende studie pakt deze uitdaging op en probeert een dergelijk alternatief voor de bestudering van bodem- en waterconservering te ontwikkelen. Daarbij wordt gebruik gemaakt van elementen uit eerdere studies, maar deze elementen worden op een nieuwe wijze geïntegreerd. In Deel 1 van dit boek worden werkwijze, theoretisch kader en methodologie beschreven. Deel 2 bestaat uit een casestudie in Burkina Faso (voormalig Boven-Volta) waarin de voorgestelde werkwijze in de praktijk wordt gebracht.

Hoofdstuk 1 geeft een beschrijving van de gekozen aanpak, die gebaseerd is op drie elementen. Ten eerste, een interdisciplinaire werkwijze om verschillende aspecten van bodem- en waterconservering te integreren. Ten tweede, een "grounded theory" methodologie waarvan het belangrijkste element bestaat uit een open opzet die de ruimte laat om concepten en principes vast te stellen vanuit de veldervaring. Tenslotte extra aandacht voor het ontwikkelen van een wederzijdse, op vertrouwen gebaseerde, verstandhouding met de dorpelingen, zodat hun meningen en visies mede richting kunnen geven aan de studie.

Hoofdstuk 2 behandelt het theoretisch kader dat voortkomt uit de "grounded theory" methodologie. Het betreft een eindproduct van het onderzoek maar wordt niettemin gepresenteerd aan het begin van het boek als een handleiding voor de analyse in Deel 2. Het theoretisch kader begint met een uiteenzetting van de meest gezaghebbende theorieën die de bestudering van bodem- en waterconservering hebben beïnvloed. Vervolgens wordt aangegeven welke elementen van deze theorieën gebruikt zijn voor het theoretisch raamwerk van deze studie. Malthus en Boserup hebben veel invloed gehad op de wijze waarop het landdegradatieprobleem gezien wordt. Beiden hebben theorieën geformuleerd die de nadruk leggen op bevolkingsdruk als de oorzaak of de oplossing voor landdegradatie. Omdat Afrika een buitengewoon sterke bevolkingsgroei heeft gekend sinds de zestiger jaren zijn deze theorieën bijzonder invloedrijk geweest in het benadrukken van bodem- en waterconserveringstechnologieën als remedie tegen het ontstaan van een ernstig landdegradatie probleem. Neo-Malthusianen stellen dat zonder bodem- en waterconserveringsinterventies van buitenaf er wijdverbreide sterfte en landdegradatie zou zijn. Neo-Boserupianen daarentegen stellen dat, als de bevolkingsdruk toeneemt tot boven een bepaalde grenswaarde, deze druk zal werken als een stimulans voor de bevolking om de landbouw te intensiveren, hetgeen tot betere vormen van landgebruik zal leiden.

Het theoretisch kader dat voortkomt uit deze studie en dat beïnvloed is door de politieke ecologie, de "lokale kennis" school en cultureel antropologische benaderingen, stelt daarentegen dat de dynamiek die ten grondslag ligt aan Afrikaanse landbouwsystemen veel verscheidener is dan een enkelvoudige trend van toenemende landdegradatie. Het theoretisch kader stelt de wijdverbreide vooronderstellingen met betrekking tot landdegradatie ter discussie. In plaats van zich te richten op bevolkingsdruk als de oorzaak of de oplossing voor landdegradatie, legt het theoretisch kader de nadruk op de interactie van sociale- en milieuprocessen, om de daaruit voortkomende dynamische landschappen te begrijpen.

Deel 2 van het boek operationaliseert deze benadering door aandacht te schenken aan: de sociaal-historische processen in het onderzoeksgebied gedurende de afgelopen eeuw (hoofdstuk 4), de lange termijn ontwikkelingen van het milieu (hoofdstuk 5), de bodem- en waterconserveringstechnologieën van de boeren (hoofdstuk 6), de lokale economische denkbeelden die het allocatievraagstuk in de landbouw beïnvloeden (hoofdstuk 7), en de wijze waarop sociale instituties en hun veranderingen door de tijd heen de manier waarop landbouw bedreven wordt in het onderzoeksgebied hebben beïnvloed (hoofdstuk 8). Vervolgens worden de verschillende delen van de analyse samengebracht om een verklaring te vinden voor het feit dat in het onderzoeksgebied alle processen hebben plaatsgevonden waarvan gewoonlijk gedacht wordt dat deze tot landdegradatie leiden, terwijl er toch geen aanwijzingen zijn gevonden dat er inderdaad landdegradatie plaatsvindt (hoofdstuk 9). De inhoud van bovengenoemde hoofdstukken wordt hieronder in detail beschreven.

De benadering van deze studie vereist om twee redenen een verscheidenheid aan methoden. Ten eerste, vanwege de veelvoud van aspecten van bodem- en waterconservering die bestudeerd dienen te worden. Ten tweede, vanwege de eerder genoemde nadruk op het laten voortkomen van de relevante onderzoeksconcepten uit het veldwerk, hetgeen een brede aanpak vereist. Hoofdstuk 3 presenteert de gehanteerde methoden en beargumenteert waarom juist deze methoden gebruikt zijn.

Deel 2 van het boek omvat de hoofdstukken 4 tot en met 9 die antwoord proberen te geven op de drie belangrijkste onderzoeksvragen. (1) Welk bewijs is er voor landdegradatie? (2) Op welke wijze conserveren mensen bodem en water? (3) Waarom conserveren mensen bodem en water op de wijze waarop zij dat doen? Hoofdstuk 4 introduceert het onderzoeksgebied en de onderzoeksdorpen en concentreert zich op de sociale geschiedenis van het gebied sinds de late negentiende eeuw. De studie vond plaats in de oostelijke regio van Burkina Faso en concentreert zich op het Gourmantché landbouwsysteem. De nadruk op de historische ontwikkelingen die dit systeem heeft ondergaan maakt het mogelijk om de analyses in de volgende hoofdstukken in een breder historisch kader te plaatsen. Een aantal van de belangrijkste veranderingen van de laatste eeuw die de bestaanswijze significant hebben beïnvloed zijn een toegenomen individualisering van productie en consumptie gekoppeld aan een afname van de macht van traditionele autoriteiten, een toename van landbouw in veldkampementen, een wijder verbreid bezit van vee onder de Gourmantché, een toegenomen gebruik van geld en een sterkere oriëntatie op de markt. Deze veranderingen zijn onder andere het gevolg van de koloniale onderdrukking en toegenomen marktintegratie. Tegelijkertijd zijn de bevolkings- en veedichtheid sterk toegenomen, wat de vraag oproept hoe dit de conditie van de natuurlijke hulpbronnen beïnvloed heeft.

Hoofdstuk 5 pakt bovengenoemde vraag op en voert een analyse op meerdere schaalniveaus uit van de indicatoren en benaderingen die gewoonlijk gebruikt worden om de aanwezigheid van landdegradatietrends te beargumenteren. Hiertoe worden oogstopbrengsten, landbouwproductiviteit, biodiversiteit en bodemvruchtbaarheid zowel ruimtelijk als in tijd geanalyseerd op nationaal-, regionaal- en dorpsniveau. Er wordt geen bewijs gevonden die de gangbare veronderstelling van wijdverbreide landdegradatie ondersteunt. Bovendien laat het hoofdstuk een aantal van de beperkingen zien die inherent zijn aan de methoden die gebruikt worden om landdegradatie vast te stellen. Gegeven het gebrek aan bewijs voor landdegradatie, de sterke bevolkingsgroei van de laatste 40 jaar en de relatief hoge rurale bevolkingsdichtheid in grote delen van het land, weerlegt het hoofdstuk Neo-Maltusiaanse voorspellingen van wijdverbreide degradatie en sterfte. In overeenstemming met het Boserupiaanse gedachtegoed suggereert het bewijsmateriaal dat in dit hoofdstuk gepresenteerd wordt dat er inderdaad een vorm van landbouwintensivering plaatsvindt die er voor zorgt dat voedselproductie gelijk opgaat met de bevolkingsgroei. In tegenstelling tot de theorie van Boserup, zijn er echter weinig aanwijzingen dat het hier een soort van intensivering betreft die gebaseerd is op veelvuldige aankoop van productiemiddelen en toegenomen mechanisatie. Er zijn ook geen aanwijzingen dat bepaalde bevolkingsdichtheden overschreden moeten worden voordat boeren gaan intensiveren en voordat boeren de duurzaamheid van hun landbouwpraktijken gaan verbeteren. Hoe deze intensivering wèl plaatsvindt en in welke vorm dat gebeurt is onderwerp van de volgende hoofdstukken.

Hoofdstuk 6, volgt de "lokale kennis" school door de bodem- en waterconserveringstechnologieën van de boeren te onderzoeken, maar richt zich niet alleen op beschrijvingen van technologieën zoals gebruikelijk is in "lokale kennis" studies, maar kijkt ook naar het gedachtegoed van de boeren met betrekking tot bodemvormings- en degradatieprocessen en met betrekking tot hun eigen rol in deze processen als gebruikers van het land. Er wordt vastgesteld dat Gourmantché boeren gebruik maken van een uitgebreid repertoire aan bodem- en waterconserveringspraktijken, waarbij het in de meeste gevallen gaat om agronomische/biologische praktijken die gebruik maken van beheersvaardigheden en biologisch materiaal. Mechanische praktijken die gebruik maken van fysieke structuren worden wel benut, maar alleen in beperkte mate, en het gebruik lijkt te zijn afgenomen vergeleken met 30 tot 40 jaar geleden. Op basis van de verhalen van informanten en een analyse van luchtfoto's wordt gesteld dat dit geen indicatie is van de achteruitgang van "traditionele" praktijken, maar een aanpassing van hun gebruik aan gewijzigde natuurlijke omstandigheden.

Een belangrijk punt in dit hoofdstuk is dat de Gourmantché boeren hun beheerspraktijken sequentieel aanpassen in zowel de loop van een groeiseizoen als gedurende de bebouwingscyclus van een veld. Dit proces van "adaptief beheer" heeft het boeren mogelijk gemaakt om bodemvruchtbaarheid te behouden of zelfs te verbeteren op bebouwde velden in vergelijking tot onbebouwd land. Adaptief beheer vereist zowel strategisch denken en experimenteren als reageren op veranderende bodemvruchtbaarheid en onvoorspelbare natuurlijke en sociaal-economische productiebeperkingen. Adaptief beheer is dus een dynamisch proces van experimenteren, afstemmen en benutten van nieuwe mogelijkheden.

Zoals beargumenteerd in het theoretisch kader is de afwezigheid van landdegradatie niet alleen een aanwijzing dat geschikte technologieën en overige productiemiddelen gebruikt worden binnen een landbouwsysteem, maar ook dat er een sociale organisatie rond het land is die het mogelijk maakt om toegang te krijgen tot de noodzakelijke hulpbronnen voor een voor het milieu duurzame vorm van landbouw.

Hoofdstuk 7 analyseert de concepten die vorm geven aan economische activiteiten, om vervolgens in hoofdstuk 8 te kunnen analyseren hoe deze concepten de toegang tot voor landbouw noodzakelijke hulpbronnen beïnvloeden. De analyse van de lokale economie vindt plaats zonder apriori aannames over het soort economie, traditioneel of markt, dat het allocatievraagstuk vormgeeft. In plaats daarvan onderzoekt hoofdstuk 7 de concepten die ten grondslag liggen aan lokale economische redenaties. Er wordt vastgesteld dat deze concepten niet gecategoriseerd kunnen worden als zuiver kapitalistisch of traditioneel. Er is eerder sprake van een mengvorm van marktprincipes en sociale overwegingen. Markttransacties zijn alom vertegenwoordigd. In levensonderhoud wordt niet alleen voorzien door zelfvoorzieningsakkerbouw, maar ook door inkomensvergaring buiten het boerenbedrijf en in de veeteelt. Boeren ondernemen ook winstgerichte activiteiten zoals het kopen van graan als het goedkoop is om het dan weer te verkopen als de prijzen hoog zijn, of bijvoorbeeld het vetmesten en doorverkopen van vee. Tegelijkertijd spelen sociale transacties zoals giften en rentevrije leningen een belangrijke rol in het dagelijkse leven. Zelfs markttransacties worden gekenmerkt door het geven van giften of kortingen. Gezamenlijk dragen deze transacties zorg voor een delicate balans tussen het maken van winst enerzijds en het aangaan en onderhouden van sociale netwerken anderzijds. Een analyse van de historische ontwikkeling van markt instituties en sociale instituties verschaft geen aanwijzingen dat sociale instituties bezig zijn vervangen te worden door markt instituties. De resulterende mengvorm van principes die de economische activiteiten vormgeven is wat wij de culturele economie noemen.

Hoofdstuk 8 kijkt naar de wijze waarop de culturele economie de manier waarop landbouw bedreven wordt beïnvloedt, en in het bijzonder hoe deze principes invloed uitoefenen op de wijze waarop het land geconserveerd wordt. Het hoofdstuk legt de nadruk op hoe veranderingen in sociale netwerken het mogelijk maken om deze in toenemende mate te gebruiken voor het verkrijgen van toegang tot de voor landbouw noodzakelijke hulpbronnen. Met het gestegen gebruik van grond voor akkerbouw is het lenen van land een mogelijkheid die benut wordt om de grond van de lineage niet te overcultiveren. Aangezien productieeenheden kleiner zijn geworden, worden netwerken in toenemende mate gebruikt om toegang te krijgen tot arbeid. Met de grotere deelname van vrouwen aan de landbouw worden de banden met de familie van herkomst gebruikt om toegang te verkrijgen tot de voor het verrichten van landbouw noodzakelijke hulpbronnen. Naarmate meer technologieën beschikbaar komen voor de akkerbouw worden netwerken aangesproken om er toegang toe te krijgen. Als Fulbe (veetelers) zich vestigen in dorpsterritoria worden nieuwe manieren van netwerkvorming ontwikkeld om het houden van vee te vergemakkelijken. Tenslotte, als de behoefte aan contant geld toeneemt, worden vormen van netwerken ontwikkeld die toegang tot contant geld mogelijk maken. De meeste studies op het gebied van landbouwproductiviteit en duurzaamheid richten zich alleen op de toegang tot hulpbronnen via geldelijke middelen. Door naar netwerken te kijken als een vorm van toegang tot hulpbronnen wordt de problematiek van de toegankelijkheid in een veel breder kader beschouwd.

De verschillende analyses in de hoofdstukken 4 tot en met 8 worden samengebracht in hoofdstuk 9 om de afwezigheid van landdegradatie in het onderzoeksgebied te verklaren. In het laatste hoofdstuk van het boek worden de conclusies van deze casestudie naar het theoretische niveau getild. De belangrijkste conclusies met betrekking tot de bestudering van bodem- en waterconservering zijn als volgt: (1) De gangbare veronderstellingen met betrekking tot landdegradatie dienen ter discussie gesteld te worden door de gegevens waarop deze gebaseerd zijn te analyseren. (2) Hoewel een hoge bevolkingsdichtheid een stimulans kan vormen voor technologische intensivering is dit zeker niet de enige aanleiding voor boeren om hun landbouwpraktijken aan te passen. Het is daarom noodzakelijk te onderzoeken hoe de bevolking zich aanpast aan veranderingen in de sociale, economische en fysieke omgeving. (3) De technologische intensivering die bereikt wordt door sommige Afrikaanse landbouwsystemen is gebaseerd op kennis van gewassen, bodem en milieu en de beheersvaardigheden waarmee deze kennis wordt toegepast. Deze vorm van intensivering heeft geleid tot hogere niveaus van productiviteit en duurzaamheid, dan de benaderingen die een kapitaalgedreven intensivering voorstaan, erkennen. (4) Er is een noodzaak voor het ontwikkelen van verbeterde wetenschappelijke methodes om de effecten van boerenpraktijken op het milieu en de landbouwproductiviteit te begrijpen. (5) Institutionele ontwikkeling in een andere dan kapitalistische vorm kan, in tegenstelling tot de aannames van studies van kapitaalgedreven intensivering, leiden tot productieve en voor het milieu duurzame landbouwpraktijken. (6) Sociale netwerken zijn niet de onveranderlijke karakteristieken van een traditioneel systeem, maar veranderen juist als een gevolg van de manier waarop mensen omgaan met veranderingen in de sociale, economische en ruimtelijke context. In die zin kunnen zij van fundamenteel belang zijn bij het bereiken van een productief en een voor het milieu duurzaam landbouwsysteem. (7) Mensen beschikken over zowel technische als sociale middelen om landbouwprestaties te beïnvloeden. (8) Vormen van intensivering in Afrikaanse productiesystemen kunnen alleen begrepen worden in termen van het dynamische samenspel tussen de sociale geschiedenis en de milieugeschiedenis van een gebied. Er is daarom een noodzaak voor een theoretisch kader dat niet uitgaat van een enkelvoudige trend van toenemende landdegradatie, maar juist gericht is op de samenhang tussen de sociale en natuurlijke context. Een dergelijke benadering verschaft inzicht in de dynamische en contrasterende trends die plaats kunnen vinden op verschillende locaties en op verschillende momenten. De voorliggende studie biedt een voorbeeld van een dergelijk theoretisch kader en de wijze waarop dit geoperationaliseerd kan worden en tot vernieuwende inzichten kan leiden met betrekking tot Afrikaanse landgebruikssystemen.

About the authors

Valentina Maria Mazzucato is an economist with a specialization in anthropology. She was born in Padua, Italy on October 20, 1965. When she was 7 years old she migrated, with her family, to the United States of America where she completed elementary, middle, and high school. Between 1983 and 1987 she obtained her B.A. degree from Williams College in Massachusetts in political science and French literature with a minor in mathematics. She then worked as a budget analyst for the Massachusetts Senate Ways and Means Committee under Senator McGovern. She was responsible for lower and higher education and the social services accounts. In 1989 she decided to quit her job and follow her longstanding dream: to live and work in Africa. With a one-way ticket and a few dollars in her pocket she tried her luck in Kenya. Within two weeks she was hired as a harambee school teacher in the Northeastern District in Merti where she taught mathematics. However, due to the difficulties in finding Kenyan teachers who would come to such an isolated part of Kenya, she soon found herself also teaching physics, heading the debate club, and coaching women's volleyball. Her time there convinced her of her desire to work in Africa. She therefore returned to the U.S.A. from 1990 to 1991 to obtain a 2-year M.Sc. degree in agricultural economics with a focus on developing countries from Michigan State University. From there she went to work for the International Service for National Agricultural Research (ISNAR) for whom she conducted economic and institutional analyses of the effects of agricultural research on farmers' livelihoods in Niger, Burkina Faso, Mali, Ivory Coast, and Senegal. In 1994 she left ISNAR to become a doctoral researcher (AIO) with Wageningen University in order to add to her work experience that of working with farmers in Africa. Between 1994 and 2000 she conducted, together with David Niemeijer, the research leading to this book which entailed living one year in Fada N'Gourma, supervising various M.A. students and a team of 5 local assistants, presenting research results at diverse international and national conferences, two of which she helped organize, and giving guest lectures in the Erosion and Soil and Water Conservation Group of the Environmental Science Department in Wageningen University. During this time she also became mother to two children. She can be reached at VMazzucato@rcl.wau.nl.

David Niemeijer is an environmental geographer. He was born on 3 September 1968 in Amsterdam, The Netherlands. He spent several of his childhood years in Sierra Leone and Kenya, which formed the basis of a long-term interest in the African continent. After completing secondary school (VWO) in 1987, he began his university education in physical geography at the University of Amsterdam. In 1990-1991 he carried out independent fieldwork on local runoff farming systems in eastern Sudan within the framework of a University of Amsterdam research project. Fieldwork was cut short after four months due to the outbreak of the Gulf War, in which the Sudanese government sided with Iraq and the

Dutch embassy no longer felt it could "guarantee" the safety of its citizens. After some hairy days in the capital Khartoum, he managed to return with 30 kilos of soil samples, as well as several notebooks with measurements and fieldnotes, which formed the source for his M.Sc. thesis. In 1992 he spent another 2 months in Africa, this time in Benin as part of a joint project of the University of Amsterdam and the Université Nationale du Bénin on environmental degradation and farmer-herdsmen relations in the Borgou province. In 1993 he obtained his M.Sc. in physical geography with courses in soil science, land evaluation, geographic information systems (GIS), remote sensing, soil and water conservation, tropical agriculture and ecology, and development geography. Shortly thereafter he was hired by the Landscape and Environmental Research Group (University of Amsterdam) on a wetlands project in The Netherlands to develop methods to detect riverbank erosion using remote sensing and GIS. At the time, he also carried out a desk study for Niemeijer Consult to evaluate the relation between soil suitability and land use in Benin. In 1994 he became a doctoral researcher (AIO) with the Erosion and Soil and Water Conservation Group of Wageningen University to carry out research on local soil and water conservation in Burkina Faso. This research, which involved 15 months of fieldwork and the supervision of students and research assistants, was carried out jointly with Valentina Mazzucato and led to the current book. At present David Niemeijer holds a post-doctoral position with the Environmental Systems Analysis Group of Wageningen University to develop ecological indicators for sustainable food production. He is also an associate with Niemeijer Consult. He is married and has one daughter. He can be reached at DNiemeijer@rcl.wau.nl or D.Niemeijer@Niemconsult.nl.