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Sustainable land management on the Central Plateau of Burkina Faso. Some implications for research strategies

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Introduction

In many parts of the world the sustainability of land use has come under threat, as increasing production pressure has led to the breakdown of shifting cultivation systems in which land is extensively used. As a result, farmers can no longer rely on the regenerative and protective functions of the natural vegetation for restoring the productivity of their land. For permanent rainfed farming to be sustained, farmers will need to invest more labour and capital in their land, through applying appropriate technologies. These changes in production need to be accompanied by changes in the farmers' socio-institutional and economic organization in order for these changes to be possible and viable.

In semi-arid regions, where population has attained relatively high densities, such as the Central Plateau of Burkina Faso, shifting cultivation has been more and more giving way, through fallowing systems, to permanent upland cropping. The necessary technological adaptations to be made for this change to be sustainable are hampered not only by an adverse physical environment, but also by unfavourable economic and institutional conditions.

In the following, a brief sketch will be given of the trends in land use and land management in this region, the measures that are to be taken to increase the sustainability of land management and some implications this has for research strategies. The material for this paper has largely been derived from experience obtained over the last four years in a research project undertaken by Wageningen Agricultural University and the University of Ouagadougou in two areas located on the Central Plateau.

The setting

The Central Plateau is situated between 11° and 14° northern latitude and covers a total area of approximately 100,000 km^2 (Figure 1), with a population of about five million people, most of whom are Mossi. They are generally poor farmers engaged in subsistent or semi-subsistent farming. The area is fairly flat with an average altitude of around 300 m above sea level. Annual rainfall ranges from about 900 mm in the south to 500 mm in the north. Rainfall is concentrated in five consecutive months of the year. Soils are predominantly kaolinitic. The landscape is typically made up of hills with laterite caps and shallow stony soils descending via sandy gentle upper slopes and loamy lower slopes to bottomlands covered with heavy clays (Figure 2). The natural vegetation consists predominantly of savanna.

The Mossi live in clusters of compounds lying at some distance from one another alongside the bottomlands. Inside and around these clusters the land is relatively fertile due to the accumulation of household refuse, nightsoil and animal droppings. It is cropped intensively, largely with maize. With increasing distance from the compounds, land is cultivated more extensively. Sorghum still predominates on semi-permanently cultivated fields. At even greater distances, if arable land is still available here, fallow cultivation is practised on outlying fields in the bush, with millet as their main crop (Figure 3).

Millet and sorghum are staples. Groundnuts and cotton are the major cash crops. The cultivation of cotton has very much declined since the droughts of the 1970s. Tillage and

weeding is done largely with hoes. Crop cultivation is a very risky undertaking due to the highly variable rainfall. Some Mossi own cattle, but goats and sheep are more common in their households. In the dry season the population engages in artisanal activities, and in some places they dig for gold. Apart from their local activities, Mossi also depend to a large extent on remittances from relatives who have migrated.

An important minority in the area are the Fulani who are known as cattle owners and herdsmen of their own cattle or animals entrusted to them by the Mossi. Although sedentarisation has become more common among them, many Fulani still move with their cattle in search of grazing lands. Natural savanna, fallowed land, and harvested cropland are all used for grazing. Of old, grazing areas offer free access to all. The bush is also a source of wood, thatch, fruits, vegetables, condiments and medicine to satisfy the needs of the local population.

Trends

Over the last decennia, the increase in population pressure on the Central Plateau has caused farmers to expand their cropping activities onto marginal lands including hillsides with shallow and gravelly soils as well as bottom lands. Simultaneously, fallowing periods have shortened or have disappeared altogether. This has resulted in widespread soil mining, loss of soil organic matter, acidification of the soil, erosion and crusting. Yields have declined as a result.

The limit of agricultural expansion has been reached. The arable area per person has generally become less than 1 ha. Labour productivity is low and is used at its maximum limit during the cropping season. Due to the expansion of cropland, the area under bush land has decreased. What is left has deteriorated due to overstocking. While grazing land has been declining, livestock numbers have been increasing, as Mossi farmers have started to keep more livestock themselves, cattle for draught power, and goats and sheep for unforeseen or exceptional expenses. Mossi farmers are also using their crop residues more and more for their own livestock while denying their use to Fulani herdsmen. The decrease in grazing areas and crop residues and declining access to waterpoints and bottomland vegetation, an important source of forage during the dry season, have increasingly constrained Fulani herding activities.

The great droughts of the early 1970s have accelerated this on-going process of land degradation. The consequent loss of food security has caused short term survival preoccupations to prevail over long term concerns. Livelihoods have come to depend a great deal on migration labour of family members in the towns, in the newly colonized lands in the southern and western parts of the country and in Ivory Coast.

Land management measures

To realize sustainable land management under these conditions, the rehabilitation and maintenance of the productive functions of the natural resources should be pursued, as a preliminary condition for the application of intensification measures to raise production. To

this end, soil and water conservation measures need to be taken, such as stone lines, earth bunds, vegetation strips and mulching. Since the 1980s the construction of stone lines has been promoted at a large scale by developing organizations in the area. It appears that their adoption has been greatest in the most densely populated villages, where land is relatively more scarce and labour more available. The total treated area is still rather small (Tables 1 and 2).

Other important measures for stabilizing the ecosystem lie in the realm of land use planning and land rights. These include the delimitation of arable land, keeping livestock and other uses of bushland at the level of the carrying capacity of the land and the promotion of regeneration by regulating access. Regulatory measures, more than others, require full participation of the population, but they are at the same time the most difficult ones to implement because they imply a recasting of land use rights, new collective responsabilities, and they bring about a sharp conflict between short term individual needs and long term collective interests. So far, measures of this nature have not been successful but on a very small scale. Clearly, they can only develop gradually.

Once water is made sufficiently available in the soil, nutrients become limiting. Without better fertilization, soil and water conservation measures may in fact only lead to more soil mining. Organic fertilizers alone are insufficient to supply the amount of nutrients required. Therefore, inorganic fertilizers are needed to fill the gap and to raise productivity, but they have to be accompanied by a sufficient supply of organic matter in the soil in order to be able to conserve and to redistribute the nutrients and to avoid acidification of the soil (Teme *et al.*, 1996). Soil organic matter can be increased with manure, compost, crop rotations and agroforestry techniques. Again, where land is most scarce and soil organic matter rates are lowest, measures to increase soil fertility are most widely applied (Tables 1 and 3). However, the amounts used are quite small and tend to be concentrated on small patches of land, the bulk of the land remaining deficient in manure. There is even less use of mineral fertilizers. The low level of commercialization of agricultural produce prevents farmers from buying external inputs.

Better and more frequent tilling and weeding techniques may also raise productivity, but they are only profitable when soils are well fertilized and the availability of water is not constrained. In the 1970s programmes were launched to promote ploughing with animal draught power but this has had little impact in the northern part of the Central Plateau because of droughts and the decline of cotton cultivation. Where it was adopted ploughing has often led to the expansion of cropland only, with yields falling soon because they were not accompanied by other measures (Kessler & Geerling, 1994).

An important avenue for increasing productivity is offered by a stronger integration of animal husbandry with crop cultivation, where crop residues are fed to livestock, and draught power and manure are used as inputs in crop cultivation. For this, the animals have to stay near the fields and regulation of grazing can be combined with hay production during the rainy season to make this possible. The ratio cropped land/rangeland has increased so much that it is impossible to sustain the nutrient status of permanently cropped land solely by the supply of manure from livestock grazed on rangelands. Complementary feeds are necessary. Their supply, however, is limited and expensive and the profitability of their use is low. For the time being, the preservation of good grazing and haying land seems to be

essential for feeding livestock and it should retain a sufficiently large area because the scope for the technical improvements of grazing land is limited (Ridder *et al.* 1982). Clearly, links between agriculture and animal husbandry have been subject to change over the last decades, although some of this change is no more than a shift away from integration between groups of land users (agriculturalists and pastoralists) towards integration of cropping and livestock at farm level, with land users becoming agro-pastoralists.

Another possibility for increasing productivity may be envisaged through the investment in small scale irrigation activities for the establishment of vegetable gardens, and orchards by means of small reservoirs or tubewells. These have in fact become widespread on the central plateau generating substantial cash incomes. However, they tend to be monopolized by families with the oldest land rights. Impounded rice cultivation in bottomlands had become of some importance in the 1950s and 1960s but has declined after the drought years due to a lowering of the water table (Lahuec, 1980).

Although it is generally agreed that the broad direction of sustainable land management should not be either ecological agriculture or intensive high external input agriculture, but one which judiciously combines the two into what has been called "eco-intensification" (Teme *et al.*, 1996), and although, very generally, the required measures are equally clear, there are still many questions as to basic processes and the application of basic knowledge to farm problems that need to be answered to arrive at sustainable land management, e.g. with respect to regeneration of degraded soils, management of biomass and organic matter in the farming system, a better use of spatial variability in the landscape, the minimization of risks in the farming enterprise, the accumulation of farming capital, improvement of collaboration among farmers and the coordination of their activities, settling of land rights and land use planning and regulation, the choice of development paths and the formulation and implementation of appropriate regional and national policies.

Some implications for research strategies

Linking research and development

Indeed, ever since the great droughts of the 1970s the Central Plateau has been the scene of an enormous amount of development, extension, and research activities in an attempt to combat land degradation and desertification, to increase agricultural productivity, and thereby to improve food security and general welfare.

Research and experimentation vary from very basic research conducted by top scientific institutes with sophisticated instruments led by mathematical models, to completely farmer designed and managed trials. Various efforts to share information and to coordinate research activities have been made. Unfortunately, these efforts tend to aim at the horizontal coordination of activities rather than their vertical integration. Separate networks exist for research institutes, for NGO's and for development projects -often limited to projects

associated with a particular organization or funded by a particular donor-[1], but structures or mechanisms integrating these various groups are hardly institutionalized. They are often created on an *adhoc* basis and are only of a temporary nature (e.g. a single conference).

The obligation of adhering to fixed disciplinary or sectoral mandates is one of the main factors that prevents genuine commitment to broader objectives thereby restricting the possibilities for true collaboration between the research, extension and development institutes and organisations. Resources are not made available for collaboration, research results are presented in ways which are inaccessible or difficult to interpret by extensionists. Development projects do not have the time and funds to resort to research institutes for certain questions.

The second factor inhibiting effective vertical integration stems from the way in which research and development activities are structured in Burkina Faso. While research is conducted by national institutes often in collaboration with foreign universities or international institutes, most of the development effort in Burkina Faso is only marginally borne by national agencies; at best they are associated. A host of bilateral and multilateral aid projects and numerous NGOs carry out the bulk of the development effort. Some foreign aid development projects have even started to shun overtly collaboration with national agencies due to the allegedly insufficient performance of the latter. Instead, they bet on the farmers and approach them directly without involving government agencies.

As a result, the research world and the development world have surprisingly little contact and they are poorly informed about the state of affairs in each other's fields. It so happens that much of what is researched and could be potentially useful for development is scarcely used by development projects, and similarly, many development problems are insufficiently being addressed by research. The lack of communication between the two and the stereotype images one has of the other has even in some instances led to a blunt "we can work without them" mentality.

Continuity and commitment

The research and development scenes are also very much characterized by their dependence on irregular funding. Development activities as much as research activities are conducted to a large extent on a project basis, rather than on a routine basis and this threatens continuity. Efforts in a certain area only last for a few years and are then stopped, simply because funding stops. Donors loose interest in some themes and get interested in others, often inspired by new developmental fashions, and shift their attention for themes and regions accordingly. The changes that have been induced or the issues studied in a certain region are

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[1] Examples of such networks are: the Inland Valley Consortium, a West African network of scientific institutes; the Réseau Agro-Ecologique, a network of NGOs in Burkina Faso with an interest combating land degradation and raising agricultural productivity; the periodic discussion groups of SNV, the Netherlands Association for Development Cooperation, to name only a few.

more than often not evaluated and not followed up. Soon the entire undertaking will be forgotten and nobody knows where to find any information about it. Similar research or development efforts may be undertaken in complete ignorance of what had been going on before.

Continuity, however, is essential where it comes to a long term process of establishing sustainable land management practices in a situation where farming systems are rapidly transformed. Steps towards new systems can only be gradual and piecemeal. Farmers will not invest in new management practices until they clearly perceive the need of it. To try to run ahead of what is perceived is almost invariably bound to fail. Also new skills need to be learned, new methods experimented with, and resources accumulated. This will all take time. Although the process requires planning with the formulation of long term and short term objectives, adjustments will have to be made during the process and new situations may arise which will pose new questions.

Therefore, it is crucial that development projects, extension services and research institutes alike have long term commitments with the farmers' communities with whom they work in order to be able to monitor progress and to assist farmers in adapting their land management practices. It would enable research workers and farmers to build mutual trust, and exchange freely among one another. It would help avoid a duplication of efforts by different research institutes unaware of each other's activities, and a better planned research (and development) effort by those involved. With an increasing knowledge of local conditions, rapid appraisals can truly be rapid and selective and become more meaningful and effective because there is a stronger basis for cross-reference and interpretation. Finally, the consistent longitudinal data set that could be created in this manner would give a much better insight into the effects of land management practices, trends and changes and a much firmer foundation for any development action.

To what extent this will be possible very much depends on the capacity and the political will of the central government to create frameworks for collaboration, and to steer development interventions and research activities. The government should be much more clear on research and development policy and the necessity to integrate them. This would also require a firmer stand towards foreign organisations and institutes that want to undertake research or development activities, the 'anything goes' policy as long as money is brought into the country in should be abandoned. On the part of the donors there should be a greater willingness to fit their money and activities in a national policy framework.

Filling in the farming systems approach

Nowadays no one will dispute the necessity of studying and solving farming problems in a farming systems context. This also applies for the problems concerning land management. Land management is first of all closely related to farmers' objectives. Farmers have an interest in practising sustainable land management in as much it enables them to attain the security they require to subsist with the productive use of their natural resources. The ways in which and the extent to which farmers can attain their objectives by practising sustainable land management depend on the resources to which they have access, complementarities between these resources, the technologies they command, their knowledge, their access to

markets and services, alternative pursuits farmers may have, etc., all components of some sort or another of the farming system.

Yet in Burkina Faso there is still a conspicuous division between technical research and socio-economic research. In conferences technicists typically sit in technical sessions with other technicists and socio-economists sit with other socio-economists. The two groups rarely meet. Research is also still very sectoral in its approach. Agriculture is studied in isolation of animal husbandry and forestry, and the whole of farming is studied in isolation of any other pursuits farmers may have.

Over the last ten years or so, however, an integrated approach has been widely advocated in Burkina's development circles. It has become known under the name of 'gestion de terroir' or 'village land management'. It is based on three pillars: (1) the potentials of the natural resources; (2) the needs of the population, and (3) the integration and coordination of the activities of every land user within a village or intervillage context in order to assure sustainability, complementarity and equity of land use (Kessler & Geerling, 1994). The development of land resources depends to a high degree on protective and regulatory measures. In the territory management approach it is up to the population of a village or a number of villages to ensure that these measures are applied. It will require the participation of the various segments of the population and should build as much as possible on existing concepts and practices.

However, there is surprisingly little research done with respect to this development approach looking at land use and management dynamics from a village level perspective. On the Central Plateau farming systems typically surpass the confines of a private farm. The open access rangelands, bushlands and fallows, which are together often designated as 'sylvo-pastoral areas', play an important role in the entire land use system as a source of organic matter and nutrients for cropping activities and as a source of other necessities.

To fill this research gap, the Sahel research programme carried out by Wageningen Agricultural University and the University of Ouagadougou has developed a resource allocation model based on multiple goal linear programming. A specific feature is that the model distinguishes several categories of land users, called actors, and that the decisions by individual actors are related to what other actors in the village do (Figure 4). Apart from taking decisions on their 'own' crop fields, actors interact through the use of common sylvo-pastoral land and the exchange of inputs and outputs. Possible actors are agriculturalists, pastoralists, households with established land rights, immigrants, males, females, etc. The model can be used to improve the understanding of farmers' behaviour; it can be used to - together with the various actors- explore development options on the basis of which development paths can be developed.

Putting participation into practice

The need for participation in the development process has been a recognized for a long time. It has now also increasingly been admitted to the realm of research. For the development of new forms of land management, the direct participation of the population is required, for it is the people who have to put sustainable land management into practice with their means, knowledge and social mechanisms. It is therefore only through them that suitable land

management measures can be developed and adapted to the prevailing circumstances.

The 'village land management' approach strongly emphasizes the need for active participation by the population using local concepts, perspectives and decision mechanisms. This participation should not be limited to issues connected with the use of private farmlands, but to communal resources and other collective interests. Establishing long term partnerships in the field of research and development with village communities would be most appropriate in this context.

The degree to which land users are allowed to genuinely participate in the research and development project, however, varies a great deal in the region. Some projects use participatory approaches, where farmers have in principle all options open to them and where a more integrated approach is taken, with ample room for mutual learning. There are equally development organisations that introduce single 'one shot' measures giving strong capital support and incentives to farmers. The large scale construction of stone lines is an example of this, with trucks transporting stones for the farmers rather than farmers organizing themselves to get the stones. They justify this single measure approach by pointing out the urgency of the land degradation problem. Here one has to weigh the possibly higher cost of land rehabilitation against the benefit of a supposedly more self-sustained participatory development process. Research should be able to indicate to what extent these claims are founded. This is important because the enormous variety of approaches and the different mixtures of participation and external support in the approaches of development and research projects creates a climate of opportunism and bargaining between the rural population on the one hand and development and research organizations on the other hand, which suffocates the spirit of truly participatory development and research. This too requires coordination of efforts.

Taking into account the macro-economic and socio-institutional context

The extent to which measures to increase productivity can be realized depends very much on policies and programmes geared to improve infrastructure and establish credit and saving structures. Moreover, they require the development of markets to which farmers have access and can fetch attractive prices for their produce and purchase inputs at affordable prices. They also require a decentralized organization of state institutions and the regulation of land rights to fill the gaps between state structures and the disintegrating traditional social and economic structures. Clearly, what is attainable in sustainable land management is very much conditioned by what is going on in society and the economy as a whole. Infrastructure, market conditions, financial policies in the Sahel are presently unfavourable for sustainable land management which requires the use of more external inputs.

Research organizations, extension agencies and regional development projects can of course not be held to deal with the macro-problems of the country, but they should take them into account in their analysis and indicate to policy makers how restrictive certain constraints are and what could happen if these constraints were reduced or entirely lifted. They should also indicate to policy makers what, how much and in what way, better land management will contribute to the development of the country as a whole by increased productivity now and for future generations. The use of behavioural farm household models may play a role

in this. Unfortunately, much technical research in the Sahel is still conducted without any or too little reference to the macro-economic and macro-social context.

Conclusion

In conclusion, the above discussion on research strategies is not meant to argue that any research project or organization should tackle each and every aspect mentioned. What is necessary, however, is willingness on the part of research and development organizations to contribute to a broader objective rather than to stick to one's own individual interests and accept the consequences of this, in trying to find outlets for the results of one's activities, in developing linkages and establishing partnerships. The whole of these interlinked actions may then converge towards the aspired objectives.

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Table 1
Land and population in six villages in Sanmatenga and Zoundwéogo provinces, Burkina Faso.

Villages	Population density (per km²)	% land cropped	land/ person (ha)	cropped/ person (ha)
Damané	188	45	0.53	0.24
Tagalla	42	14	2.35	0.33
Sidogo	178	69	0.56	0.39
Barsé	52	20	1.92	0.39
Yakin	137	57	0.73	0.41
Kaibo-Sud V5	91	60	1.10	0.66

Table 2
Erosion control measures applied (% of cropped area)

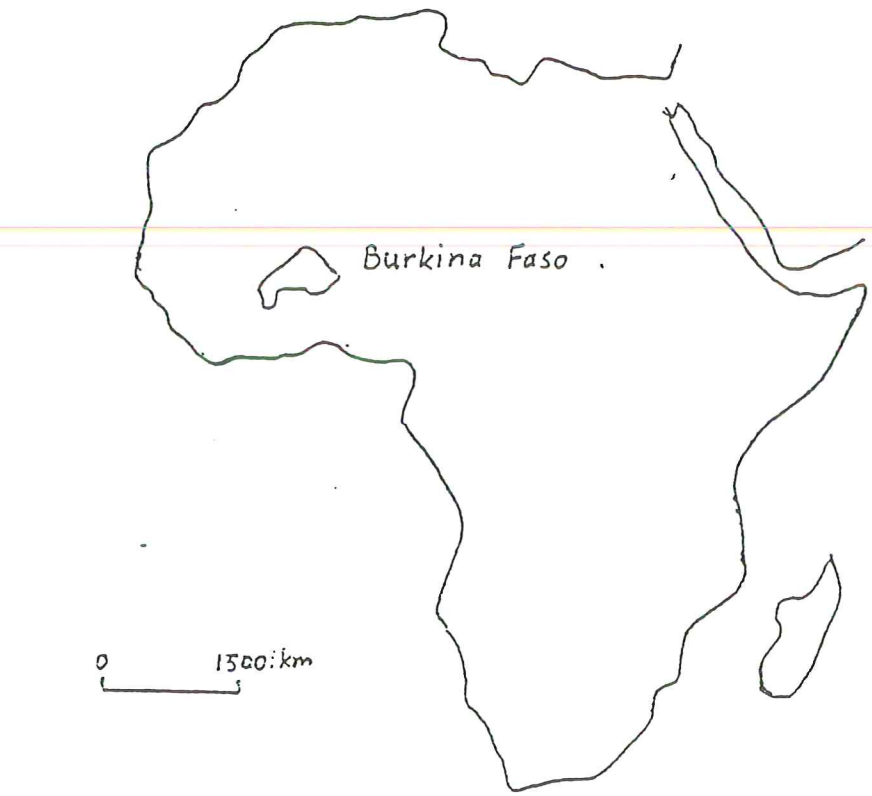
Villages	Stone rows	earth bunds	grass strips	One or more measures
Damané (25)	38	0	18	53
Tagalla (26)	30	0	22	49
Sidogo (31)	31	14	20	62
Barsé (28)	1	10	4	13
Yakin (25)	15	19	4	36
Kaibo-Sud V5 (25)	15	0	3	17

Table 3
Practices for soil fertility maintenance (% of sample housholds)

Villages	Organic matter (%)	Mulch	Manure/ compost	Mineral fertilizer
Damané (25)	0.3 (10)	64	44	8
Tagalla (26)	0.8 (11)	27	15	15
Sidogo (31)	0.4 (10)	58	48	42
Barsé (28)	0.8 (10)	4	21	0
Yakin (25)	0.6 (6)	12	48	32
Kaibo-Sud (25)	0.8 (6)	-	44	44

Source: adapted from de Graaff (1996)

Figure 1


Burkina Faso
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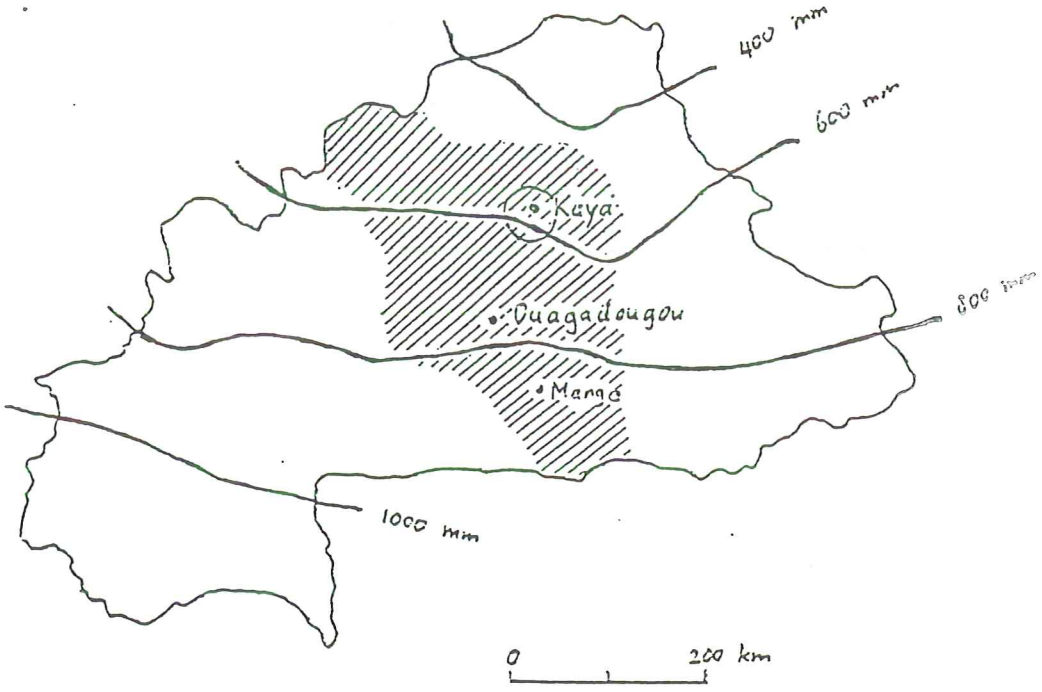

400 mm
600 mm
800 mm
1000 mm
Kaya
Ouagadougou
Mango
0
200 km

Figure 2

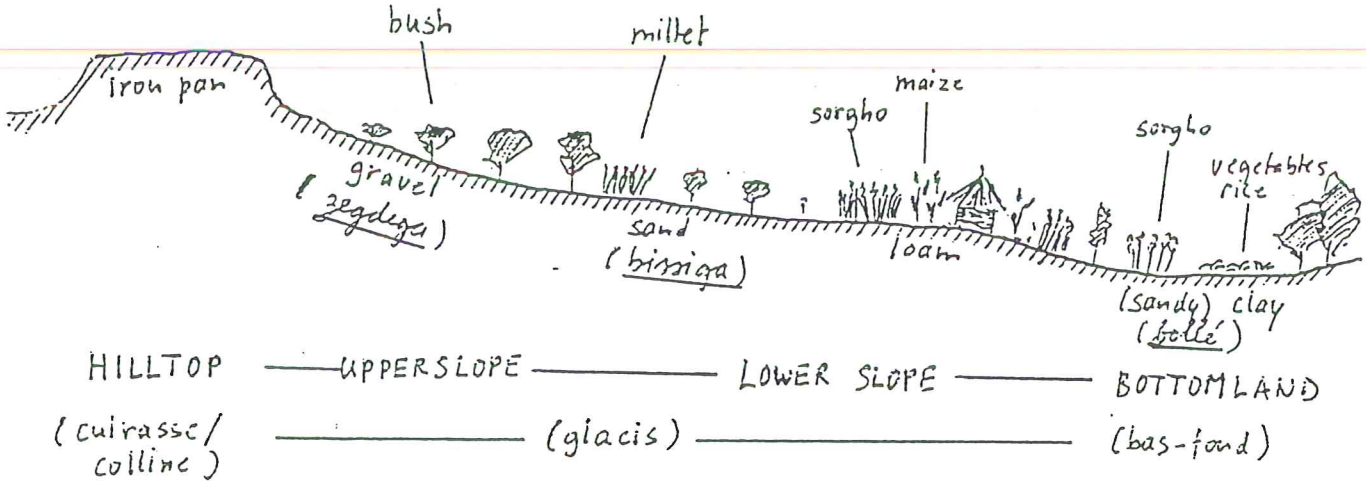
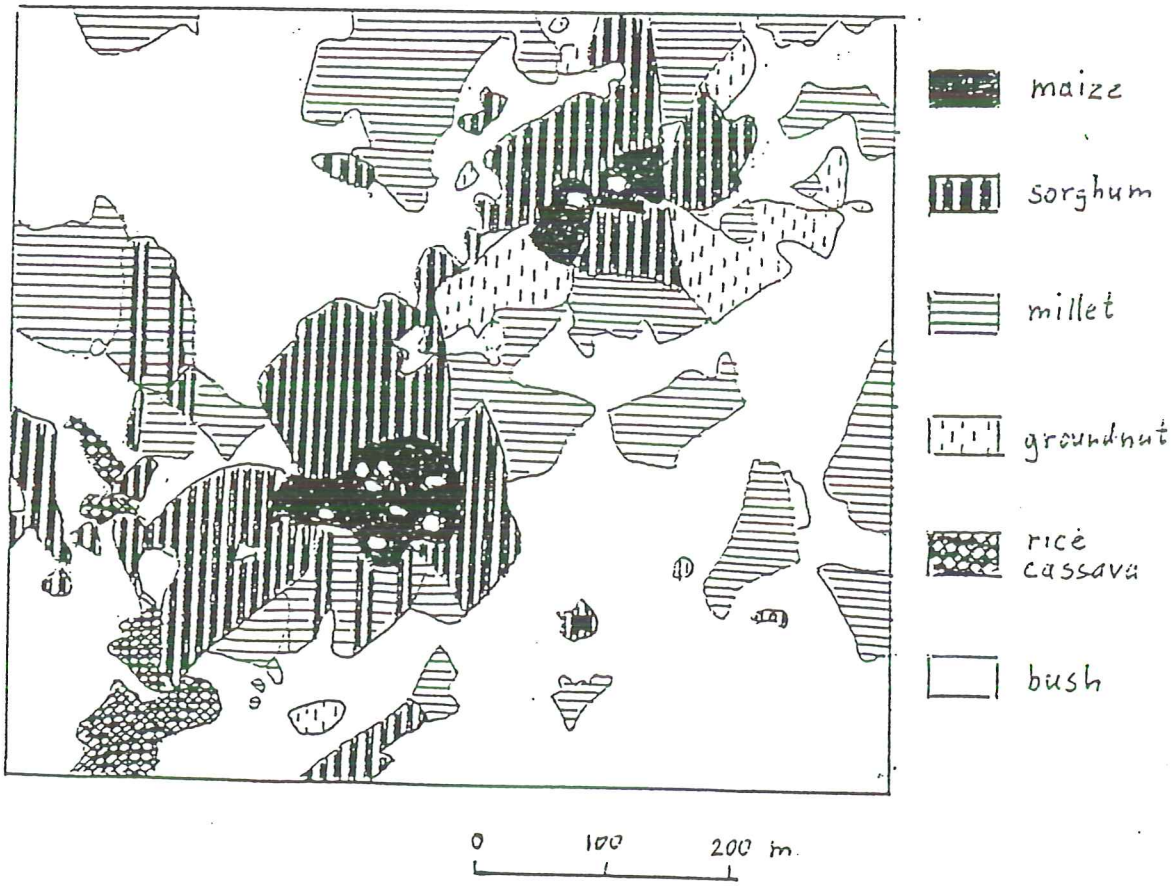


Figure 3



Conceptual structure of SHARES

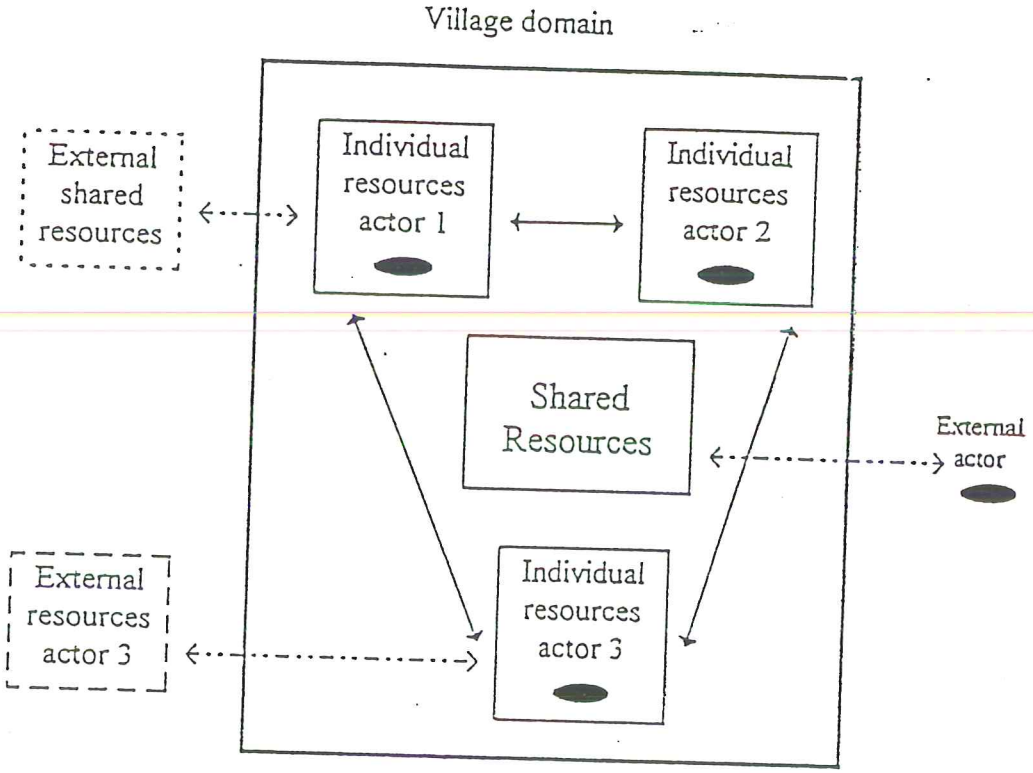


Figure 4

PUBLICATIONS PARUES (depuis le 1er janvier 1995):

Documents du projet (rouge)

21	J.W. Nibbering	Glossaires français-néerlandais et néerlandais-français de termes utilesés dans l'étude des aspects sociaux et économiques de l'agriculture
23	J.W. Nibbering	Liste des termes français-neérlandais et néerlandais-français employés pour la description de l'état des paysages, des processus s'y déroulant et des agents modificateurs
24	J. Begemann e.a.	Antenne Sahélienne UAW/UO. Rapport Annuel 1994 et Perspectives 1995
27	J.W. Nibbering	Modelling of resource utilization and management: Models presented at the PSS/DLV/ESPGRN-Sikasso workshop in Niono from 18 to 20 september 1994
28	J. de Graaff	La situation agro-economiques et les mesures anti-erosives dans six villages sur le plateau mossi (Quelques données des enquêtes agro-économiques 1992-1994)
29	D. Niemeijer & V. Mazzucato	Agriculture and water conservation in Eastern Burkina Faso; a first appraisal (aussi disponible en français)
30	M.A. Mulders	Inventory of Soil, Land Use and Erosion Hazard at Medium Scale in the Kaya Region.
31	M.A. Mulders & K.F. Wiersum	Land Degradation: Concepts, Processes and Assessment.
32	K.F. Wiersum, R.Behnke e.a.	Emerging new concepts in analyzing land-use in semi-arid regions; papers presented at a workshop held at October 19, 1995
33	E.H. van Haaften & F.J.R. van de Vijver	Indicators for Human Carrying Capacity in sustainable forestry; Psychological Stress and Marginalisation in deforestating areas.
34	J.J. Kesler & K.F. Wiersum	Forest Policy Development in the Sahel: Contexts, Processes, Contents and Impact.
35	J.W. Nibbering	Publications et rapports du programme Gestion des Ressources au Sahel préparés pendant la période de 1992-1995.
36	J.W. Nibbering	Annotated list of Journals that are of Interest for studying the Human Context and the Human-natural Interface of Natural Resource Use and Management. With special references to the Sahel.
37	J. Begeman e.a.	Antenne Sahélienne UAW/OU. Rapport Annuel 1995 et Perspectives 1996
38	V. Mazzucato & D. Niemeijer	Coping with changes in an agricultural system in Eastern Burkina Faso (aussi disponible en français)
39	M. Mulders	Soil and land use of the kaibo area at medium scale.
40	R. Nikiema	Etude du milieu social du village de Tagalla province du Sanmantenga.
41	K.F. Wiersum & M. Slingerland	Use and management of two multipurpose tree species (*Parkia biglobosa* and *Detarium microcarpum*) in agrosilvopastoral land-use systems in Burkina Faso.
42	M.A. Mulders & Lamine Zerbo	Explications additives du rapport de kaibo sud V5
43	J.W. Nibbering	SHARES. Moddeling shared resources in the Sahel: concepts, techniques and examples.
44		Verslag VF-Sahel dagen. 22-25 April 1997
45	L.Stroosnijder & T. van Rheenen	Book outline
46	H. Hengsdijk	A Technical Coefficient Generator for Tagala
47	T. van Rheenen	IO-Coefficients for the descriptive mode of shares to be screened by VF-Sahel researchers
48	M.A. Slingerland & M. Savadogo	Etude agro-écologique de quatre terroirs villageois du plateau central burkinabé

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