Dangerous Assumptions.
The Agroecology and Ethnobiology of Traditional Polyculture Cassava Systems in Rural Cameroon and Implications of Green Revolution Technologies for Sustainability, Food Security, and Rural Welfare

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Dedication

TO

My Late Father, Papa Ntumngia Samuel Ngwa.

My Mother, Mami Phoebe Bih Ntumngia

My Four Children

Shu Sidney Ngwa
Shu Rhim Suh Ngu’eh
Shu Reynard Neba Tanifum
Shu Elkyie Yollande Ngum
and

My Friend, Eelkje van de Helm

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We thank the almighty God
for giving us cassava
We hail thee cassava
The great cassava

You grow in poor soils
You grow in rich soils
You grow in gardens
You grow in farms

You are easy to grow
Children can plant you
Women can plant you
Everybody can plant you

We must sing for you
Great cassava, we must sing
We must not forget
Thee, the great one

Flora Nwapa (Nigeria)
Cassava Song and Rice Song (1986)

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CHAPTER ONE
INTRODUCTION

1.1 The Alliance for a New Green Revolution in Africa: Assumptions and Parameters

Several leading international organisations as well as governments have recently formed an alliance to promote a "New Green Revolution for Africa," where high yielding crop varieties and other inputs, especially fertilisers, are being promoted as a solution to the continents' poor yields. Essentially, the arguments made by the Alliance for a New Green Revolution in Africa (AGRA) about African agroecology are that traditional farming systems and practices suffer from low productivity and are unsustainable. African soils are naturally poor, farmers use little or no fertiliser, and the fallow periods that, in the past, provided for nutrient recycling, are declining due to population pressure, leading farmers to mine the soil, which results in declining crop yields. Further, farmers' local varieties are low yielding and are highly susceptible to pests and diseases compared to improved, high-yielding varieties (HYVs). Across Africa, per capita food production is declining, and families live in poverty and hunger. Population pressure is increasing, farmers are poor and thus in need of additional income and, if given the opportunity, they will seek to maximise their income from crops sales, which they in turn will reinvest in agriculture, given the right incentives. Farm households are food insecure and, by increasing their output and sales, they will become food secure. AGRA is a partnership agreement between the Rockefeller Foundation and the Bill and Melinda Gates Foundation, which was created in 2006 ostensibly in response to the need to help millions of small-scale African farmers to rapidly and sustainably increase their productivity and lift themselves out of poverty. This partnership is intended to improve agricultural development in Africa by addressing issues related to soil fertility and irrigation, farmer management practices, improving planting material quality and productivity, and access to markets and financing. Essentially, AGRA proposes to intensify and further commoditise what are often small-scale, mainly subsistence oriented, traditional agricultural production systems across Africa: without this, the term "green revolution" would hardly be justified.

To pursue such an agenda, AGRA makes a set of assertions, or arguments, about African agriculture and African farmers, which are referred to throughout this dissertation as assumptions. In addition, two sets of parameters can be discovered that underlie these assumptions that are thought to determine the performance of African agricultural systems: one set is agroecological and the other is socio-economic. Most of the assumptions made by AGRA are about its presumed agroecological parameters, and only a few, albeit critical assumptions, are made about its presumed socio-economic parameters. Further, when critically assessing these, it becomes apparent that an understanding of the relations between these two sets of parameters (how they influence each other) is largely missing in AGRA's discourse. In the absence of an understanding of the relations between the agroecological and the social in the African context, AGRA's assumptions and prescriptions are understandably highly generalised. Yet, if anything characterises African agroecology and social relations, it is diversity: biological, physical, and cultural. Increasingly, scholars recognise that this diversity of cultures, agroecologies, and biological resources is very probably not coincidental: each may beget the other (biological diversity and cultural diversity co-evolve).

This does not imply that AGRA is wholly ignorant of the importance of biological and cultural diversity in Africa. Any careful examination of the potential effects of a “New” Green Revolution across the continent must take into account experiences with the ‘Old’ (and, it is readily acknowledged, largely failed) efforts to promote agricultural intensification *a la* Asia. The “New” is added in an attempt to demonstrate that the institutions that promoted the ‘Old’ Green Revolution in Africa have learned from the successes and failures of the past: while drawing upon the successes of the ‘Old’ Green Revolution especially in other world regions, it aims at correcting past errors by promoting participatory plant breeding (PPB), and by breeding a wider range of crop varieties for a diversity of agroecological niches. It also emphasises soils and recognises that soil fertility improvement requires an integrated soil fertility management (ISFM) approach that combines mineral and chemical fertilisers with the use of farmers’ soil organic matter improvement strategies. In so doing, it explicitly recognises the value of farmers’ knowledge, which, like their agroecological conditions, is local and diverse.

Nevertheless, it is argued throughout this dissertation that the “New” Green Revolution, much like the ‘old’, continues to be heavily biased toward existing Western scientific knowledge and, within this, toward the Western biophysical sciences. AGRA and other similar programmes acknowledge few serious gaps in such knowledge that might compromise the success of its programmes, and they also fail to consider the breadth of African indigenous or local knowledge and its rationale. Insofar as socio-economic phenomena are considered at all, the assumptions are biased toward neoliberal and neo-classical economics, which are ignorant of Africa’s traditional moral economies and cultures that are the subject of much anthropological and sociological research. Decades on, and with continuing attempts to implement the ‘old’ (as well as many elements of the ‘new’) Green Revolution in Africa, many scholars and practitioners consider that it is necessary to thoroughly understand how farmers’ own (‘emic’) perspectives and experiences influence and are influenced by farming systems and agroecological conditions, how these underlie their choice of crops and crop varieties and their soil management strategies and techniques and, as well, how such perspectives and experiences are related to their cultures, moral economies, and to the respective political economies of their nations and continent. Many would argue that culture and local knowledge are among the main parameters that determine the nature and performance of African smallholder farming systems, their future sustainability, and the well being of its rural people. However, it will be shown that AGRA’s framework does not relate agroecology and farming systems to culture, but instead virtually ignores the latter, and analyses social relations and agroecology as though these were separate and unrelated entities. Farmers’ traditional knowledge and practices, and cultural phenomena including traditional relations of production, receive very short shrift in AGRA and many other similar programmes and initiatives.

It could be argued that the types of agroecological generalisations that AGRA makes about African farming systems may characterise some parts of Africa although, even in these cases, in-depth research would almost certainly show that the causal relations posited are highly oversimplified and very probably obfuscating; the proposed solutions are also likely to be problematic, not leastwise because many smallholder African farmers may be unlikely to accept them. Nevertheless, this dissertation not only sets out to investigate whether such assumptions do not hold across all of Africa - it would be only too easy to demonstrate that they do not. Rather, it intends to show that the thinking behind AGRA and related government policies and programmes does not actually consider real African farming systems and real African farmers and how and why they function as they do which, it is argued, must serve as the point of departure for agricultural policies and programmes across the region if these are to succeed in supporting such farmers, their communities, and their nations.

The overall aim of the research was to understand the implications of policies and goals that promote Green Revolution technologies and market integration in Africa for the productivity and sustainability of traditional agroecological systems, crop varieties and their conservation, and the livelihoods, income, food and nutritional security of small farm households. It addresses questions such as: Do African farming systems, and farmers, have the characteristics that AGRA attributes to them? Are such farmers likely to adopt the technologies that are promoted? Are the technologies and strategies that are promoted likely to lead to more sustainable, higher yielding farming systems? Are they likely to translate into higher incomes, greater food security, and renewed investment in agricultural intensification? Are there in fact trade-offs that farmers and their households and communities would have to confront and, if so, how do these influence their strategies and responses to programmes that promote Green Revolution type intensification?

The findings presented herein indicate that AGRA's rationale and prescriptions represents not so much a "New" approach as a continuation of "Old" search for scientific and market-based solutions to the problems of African agriculture by promoting HYVs, use of other external inputs, and increased integration of farmers into input and output markets. Farmers are still seen essentially as passive recipients of technology, who are waiting for outside support so that they can act like proper business people, producing surpluses for the market and maximising and reinvesting their incomes. Farmers' culture, social relations, knowledge, practices, and experiences remain, in the 'New' Green Revolution, as in the 'Old', a black box. This dissertation, then, challenges both the identification of parameters and the assumptions made about these parameters by AGRA and by other, similar, efforts to 'modernise' and 'revolutionise' African agriculture. Case study research is used to examine the assumptions and to discover whether the AGRA parameters, or a different set of parameters, hold, at minimum with respect to the research sites, to draw out the implications of programmes and policies based on these assumptions and parameters, and their potential dangers for African agriculture and the households that depends on it, and to reformulate them where they do not hold.

1.2 The Green Revolution Comes to Cassava and to Cameroon's Food Crop Sector

The research that is presented herein addresses the assumptions of AGRA and of other related initiatives and their applicability to cassava in two case study research sites in Cameroon. In light of the findings, it addresses the potential consequences of increased fertiliser use and further diffusion of HYVs that substitute local varieties for the livelihoods, income, food security, and agroecological sustainability of African smallholder farming systems and households. It focuses on cassava (Manihot esculenta Crantz) - a crop that is very important for food security over much of Africa as well as across the tropics, which has been the subject of concerted research and extension for at least three decades. Governments and international organisations have been promoting increased commercialisation of cassava both as a food and an industrial crop and, most recently, it has also been a focus of collaboration between the CGIAR institutions and AGRA, where the International Centre for Tropical Agriculture (CIAT) has been working on integrated soil fertility management strategies for the crop.

Cassava, which originated in South America, gained international interest in the 1960s as a result of the limited supply of energy food to feed the world's growing population. The importance of cassava lies in its ability to produce more food using less labour on poorer land compared to other food crops. Given the high priority for breeding and related research, centres such as the International Institute of Tropical Agriculture (IITA) and CIAT were tasked with establishing breeding programmes with a global perspective that would generate economic benefits for the rural poor. CIAT and IITA have mandates to improve cassava root quality, yields per unit area, and area under cultivation. As a result, new varieties (cultivars) have been developed and released through collaboration with international and national programs in Latin America, Asia, and Africa. The major research focus has been on breeding for high yields, resistance to major diseases and pests, reduced cyanide content, adaptation to a wide range of ecological conditions and farming systems; and developing rapid plant material multiplication techniques, biological control of the cassava mealy bug, and taste and quality improvement of fresh storage roots. Breeding for resistance to root rot disease is the most recent (2007) achievement.

This dissertation examines the effects of the promotion of high yielding cassava varieties (HYVs) and cassava commercialisation in Cameroon, where cassava is one of the most important domestic food crops. Until the mid-1980s, policy-makers emphasised traditional export crops to the neglect of the domestic food crop sector but, when the value of its export crops fell, policies were reformulated and, by the 1990s, the government sought to consolidate the achievement of food self-sufficiency and to increase export earnings by diversifying, modernising, and improving the marketing potential of domestic food crops (MINAGRI, 1990). The modernisation of traditional food crop production systems has since been considered to be a *sine qua non* of agricultural policy, which is implied in all of the strategies aimed at improving agricultural production and achieving rural development in Cameroon. The modernisation of agricultural production systems is seen in terms of intensification and development of food crops with high economic potential (cash crops). Cassava features among the eight crops that are considered to have such economic potential in Cameroon, where the vision is to encourage profitability and promote the emergence of a market for factors of production. The availability of inputs, the viability of production systems, the promotion of technology, added value, and improvement of processing, competitiveness, and support for producer organisations are some of the 19 areas of intervention envisaged. The main focus has been on plant breeding and intensification of agronomic research, soil conservation and rehabilitation, agricultural mechanisation, and extension. One of the ultimate goals is to increase cassava production and marketing.

From 1986 onwards, cassava HYVs have been, and are being, developed by national and regional research institutions and released to farmers through extension services. The main orientation in research is to increase food crop production through breeding for pest and disease resistance, vigour, high yields, adaptability, and acceptability of locally established varieties; the development and diffusion of improved agronomic techniques and of rapid multiplication techniques for improved plant material; the protein enrichment of some processed cassava products such as cassava flour, appropriate processing and storage techniques, and improved marketing for cassava and its derived products. Since 1986, some 25 cassava HYVs have been released to farmers in Cameroon, nine of which were released between 1986 and 1990 and, by 2002, 13 varieties in total were released. Since 1979, IITA Ibadan, Nigeria has been forwarding a bulk of seed material to IRAD Cameroon and, currently, to IITA Nkolbison, Cameroon, for on-station and on-farm trials to determine adaptability in Cameroon and permit onward release to farmers. Since production is targeted at the market, all of the varieties released to date are early maturing, since these provide the most rapid turnover.

While cassava has been promoted as a means to ensure food security and generate income for small farmers, the Cameroon Government and the international organisations mentioned above have paid most attention to its economic importance. As such, market-oriented policies and goals have been elaborated that aim at increasing productivity and production through the use of external inputs in order to meet market demands for specific cassava products, including a strong increase in industrial processing and use.

1.3 Testing Assumptions and Unearthing Parameters

The hypotheses developed in the dissertation challenge many of the assumptions that have been put forth by AGRA that are also explicit or implicit in many other policies and programmes that promote Green Revolution-type responses to the problems these identify in Africa. Such assumptions and solutions often target smallholders and agroecosystems that, in spite of commoditisation, religious conversion, colonial and post-colonial rule, etc., remain firmly embedded in ethnic and tribal communities that strongly adhere to cultural norms, beliefs, and social relations. Within these communities, agricultural knowledge and practices are often based largely on local knowledge and resources, and farmers' decisions are strongly influenced by such knowledge and culture. The conceptual framework, discussed in detail in Chapter 3, first and foremost posits that such 'traditional' agricultural systems generally represent a long-term adaptation between culture and the environment, where both have co-evolved over time. Traditional farming practices and knowledge have developed through different forms of social learning, experimentation and trial-and-error, and are transmitted across generations by many cultural means. Traditional ecological knowledge (TEK) and practices are in part embedded in belief systems that are specific to different cultural groups, and have their explanations, in many cases, in the spirit world and in myth. Of course, throughout history, farmers' knowledge and practices have also been influenced by outsiders' knowledge and experiences and, therefore, their farming systems are a manifestation of their own and other peoples' cultures and worldviews. For example, farmers develop local crop varieties and they also incorporate crop varieties from other cultures and regions into their farming systems, where they experiment and adapt those they consider to be desirable to suit their farming systems and social relations. The adoption of cassava in Africa changed local food habits, social relations, and agroecological systems; at the same time, these also shaped the evolution of cassava as a cultivar, a food, and a cultural symbol. Farmers' knowledge and practices are embedded in social relations, where many modes of subsistence are characterised by forms of communalism that are relatively egalitarian, which tends to ensure that resources are distributed in such a way that people have sufficient means to meet socially defined, as well as biological needs. Further, subsistence practices that tend to ensure that natural resources and ecosystems are sustainably managed are often embedded in traditional belief systems that imbue the natural world with symbolic and religious meaning, and that see humans as an integral part of nature. Unsustainable practices and inegalitarian social relations are likely to be mal-adaptive over the long run, and societies that have persevered over long time periods are seen by scholars to be largely adaptive, sustainable, and resilient.

The hypotheses tested in the research that is presented in this dissertation are not only the product of such a conceptual framework: they also stem from my 25 years' experience as an employee of the Ministry of Agriculture and Rural Development in Cameroon. Since 2005, I have been Chief of Service in charge of Relations with Agricultural Research, and in this capacity I helped to define national extension policy as well as strategies for mobilising agricultural research results for onward transmission to farmers. Prior to this, I served for eight years as Assistant Unit Head in charge of Extension Norms and Methods, which included the development and implementation of participatory diagnoses of farm households with special attention to vulnerable groups (in collaboration with agricultural research and farmer organisations), elaboration of extension manuals and guidelines, participatory monitoring and evaluation of on-farm trials, definition of gender- and HIV/AIDS-sensitive national agricultural extension policies and strategies, and oversight of the creation of nearly 14,000 grassroots farm organisations. Prior to this, for two years I held the post of Controller of National FAO/PAM projects for the Littoral and Southwest Provinces, after having served for eight years as Provincial Coordinator of FAO/PAM projects for the Northwest Province. I have worked as an agricultural extension agent and have trained and supervised grassroots and provincial level extension staff, and monitored and evaluated extension activities. I led the creation of a national database on problems and constraints that farmers face in agricultural production, postharvest handling, and commercialisation for onward transmission to research institutes, and as well led the process of upgrading a national database on existing farming systems in Cameroon.

Besides this field-based experience, I carried out Masters dissertation research on gender power dynamics and knowledge systems and their relation with household food security among cassava farmers in two villages of the Southwest Province of Cameroon: Mautu and Malende, where Malende is one of the villages that is the subject of the present research. The dissertation analysed policies that promote the intensification and commercialisation of cassava, a woman's crop, and their implications for welfare and equity at farm household level as men moved into cassava production. It addressed the interactions between men and women in cassava production, processing, and commercialisation, examining the division of labour, access to and control over resources and benefits, decision-making authority within the household, and labour and market organisation and the changes that occurred as a result of men's increased participation. The research showed that men did not assume control over the resources and benefits of cassava production despite increased involvement: rather, they employed women for specialised tasks such as weeding, processing, and marketing. This contradicted the popular view that, when women's crops are commercialised, men take over production to the disadvantage of women. The cultural norms, values, and beliefs that define gender ideologies were identified as important explanations for why men did not take over cassava production in a way that excluded women, and why women were able to benefit from increased commercialisation of the crop.

The specific topics that are the subject of the current research deal with the key assumptions and underlying parameters posed by AGRA, but the research goes beyond these as necessary in order to understand the factors that explain why farmers do or not accept the types of Green Revolution innovations that are so widely promoted and, when they do accept such innovations, what they accept, in which circumstances, why, and to what effect. It explores in-depth three sets of parameters:

i. Agroecological: critically assesses assumptions about soils, yields, farming systems, and crop and soil fertility management;
ii. Local cultivars and HYVs: assesses farmer knowledge, perceptions and understanding of cultivars, which are the means by which they evaluate HYVs, which in part determines their adoption or non-adoption;
iii. Socio-economic and cultural: critically assesses assumptions about livelihoods, food security, income, crop commercialisation, and farmers' goals, and systematically relates these to agroecological conditions and strategies, to cultivar management, to input use, and to commercialisation.

To examine the assumptions and underlying parameters related to the promotion of Green Revolution ('old' or 'new') technologies and greater market integration on the part of the Government of Cameroon, AGRA and the CGIAR institutions in relation to cassava, comparative research was carried out in two case study villages. The aim of understanding the implications of policies and goals that promote Green Revolution technologies and market integration for the productivity and sustainability of traditional agroecological systems, crop varieties and their conservation, livelihoods, income, food and nutritional security required a comparative analysis of areas that have been over a relatively long period subjected to the promotion of AGRA-type recommendations (especially the use of HYVs and fertilisers). As indicated above, Cameroon, with the assistance of CGIAR institutions, has been promoting such innovations since at least the early 1990s. Within Cameroon, two villages were selected in the 'cassava belt' (Koudandeng and Malende) where the Government has focused efforts to diffuse HYVs, promote use of complementary inputs and techniques, and increase commercialisation especially of HYVs and their products. Malende is a less ethnically-homogeneous, more commercially oriented village that has been the subject of intense government and NGO intervention, whereas Koudandeng is an ethnically homogeneous, less commercially oriented village that has not been the subject of intense intervention, but that still has access to, and knowledge of, Green Revolution inputs. It is argued that Malende and Koudandeng represent an adequate empirical basis for examining the relevance of the goals, the validity of the assumptions, and the appropriateness of the modes of implementation of such policies. The comparative design and the selection criteria for these two villages are discussed in-depth in Chapter 3.

1.4 Research Objectives and Hypotheses, and Outline of the Dissertation

The ***overall aim*** of the research is to understand the implications of policies and goals that promote Green Revolution technologies and market integration in Africa for the productivity and sustainability of traditional agroecological systems, crop varieties and their conservation, and the livelihoods, income, food and nutritional security of small farm households.

A ***first sub-objective*** is to gain a clear understanding of the implications of the promotion of cassava HYVs and the use of agricultural inputs, particularly chemical fertilisers, for the sustainability and resilience of traditional farming systems, food and nutritional security, rural livelihoods and income, so as to make policy recommendations, contribute to international and national debates and provide a reference document for researchers.

A ***second sub-objective*** is to critically examine the assumptions and underlying parameters posited by the Alliance for a New Green Revolution in Africa, and to reformulate these to provide a more adequate framework for approaching and assessing agricultural innovations in the African context.

The hypotheses that guided the research are:

1. If African smallholders' objective is mainly to increase productivity (yield per unit area) and, if local varieties are actually low yielding, and then HYVs should outcompete their local varieties. HYVs would therefore have a higher level of salience (meaningfulness) among farmers due to the comparative advantages that they have over local varieties.
2. Correcting the errors of the past Green Revolution by forming a partnership with and drawing upon the local knowledge of small-scale farmers may not be effective for national and regional research institutions responsible for the development of cassava HYVs since no concrete methodology for achieving this has been specified.
3. Most often, the productivity of cereal crops are used to draw conclusions about the productivity of traditional African farming systems and the food security status of households, whereas cereals are not staple crops for many African communities and therefore their production is bound to be low compared to roots and tubers crops and plantain/banana.
4. The traditional agroecological systems under study are more adaptive, resilient, and sustainable and higher yielding, compared to high input monoculture systems that depend on external inputs, which are generally promoted by research institutions, AGRA, and the Cameroon Government.
5. In the study area, which is representative of the 'high end' of cassava production in Cameroon, cassava farmers' objectives are to ensure food security and a livelihood and their food production systems actually achieve these objectives, whereas the production systems of high yielding cassava varieties (HYVs) contribute relatively little.

Chapter 2 presents an overview of the importance of cassava across the tropics and in Africa, and a general outline of the policies, goals, assumptions, and research orientations related to cassava in developing regions, with a special emphasis on Cameroon and on the two regions within it that are the focus of this dissertation. It compares and contrasts the Cameroon Government's policies with the goals, assumptions, and modalities of implementation of AGRA and of the CGIAR institutions that deal with cassava (IITA-Nigeria and CIAT-Columbia) and discusses some of the factors that have influenced the development of each policy, goal, and orientation. It briefly discusses the characteristics and dynamics of cassava production, processing, and marketing in Cameroon in general, and in Malende and Koudandeng in particular. The main arguments made in this dissertation are presented in terms of the assumptions and lacunae in the current sets of policies and practices that are examined in relation to the cultural, economic, and agroecological dynamics of Malende and Koudandeng. The essential comparative information on the study site populations of Koudandeng and Malende is also presented.

Chapter 3 presents and discusses the conceptual framework and the methodology used in this dissertation. It begins by defining and discussing the concepts and conceptual frameworks that have guided the elaboration of the research objectives, hypotheses, and the analysis. Then, the comparative research design, methods, and protocols that were used to collect and analyse the data are discussed, as well as their limitations.

Chapter 4 analyses farmers' cassava-based agroecological systems and their capacity to ensure sustainable livelihoods through agriculture which, as is argued here and elsewhere in this dissertation, is the prime objective of traditional and subsistence farmers in the study area and elsewhere. It especially questions whether the use of chemical fertilisers, as promoted by the Cameroon Government, AGRA, and other agricultural development institutions, is necessary given the nature of traditional agroecological systems, or desirable given the current and projected future socio-economic conditions that farmers confront. It examines some of the assumptions made by AGRA, which are also implied in the thinking behind the promotion of improved crop varieties and fertiliser use by the Government of Cameroon, and in crop research and development, and presents the hypotheses that are examined in this chapter with respect to these assumptions. It briefly discusses the methodology used for data collection and analysis and then presents and discusses the research results. It revisits the ideology that is central to AGRA and many other agricultural modernisation programmes, which insists that African farming is backward and unproductive or environmentally degrading. It highlights the inappropriateness of promoting agrochemicals as a response to the problem of African food security, and discusses the resilience and reliability of traditional cassava polyculture systems.

Chapter 5 discusses the general assumptions behind AGRA and the Cameroon Government's cassava improvement and dissemination programme, and contrasts these with farmers' varietal knowledge, perceptions, and actual cassava diversity and adoption of HYVs in the study villages. The major assumptions of AGRA and the Cameroon government policy are examined and related to a discussion of the importance of local cultivars and farmers' local knowledge, of varietal preferences, and of what they actually grow, which raises concerns about cassava diversity. The assumption that cassava HYVs varieties out-perform traditional varieties is critically examined, particularly by focusing on the socioeconomic and demographic attributes of farmers that are statistically significant in explaining the variation in the varieties and the varietal attributes that seem to order the classification of these varieties. It argues that cassava farmers' primary objective is not to increase production, but rather to ensure food security and livelihoods and meet cultural needs. The implication of the spread of HIV/AIDS pandemic for cassava varietal diversity and intra-generational knowledge in the study area is also explored.

Chapter 6 focuses on the relationship between traditional farming systems, cassava production, culture, food security, food and foodways, biodiversity and dietary diversity and nutrition, livelihoods, and the goals of traditional farm households of Koudandeng and Malende. It identifies and addresses the threats posed by widespread diffusion of HYVs, the modern intensification of agriculture (including conversion to monoculture) and of increased participation in factor and output markets for farm households in relation to current performance. It specifically questions whether food security for Africa can be achieved only by focusing on food availability in terms of volume and stability of production, while neglecting the multiple goals that farmers pursue.

Chapter 7 concludes the findings by re-examining the assumptions and parameters underlying the promotion of cassava HYVs and fertiliser use, and contrasts these with parameters identified by examining in-depth farmers' management of their traditional farming systems and crop varieties. It summaries the findings of this dissertation in relation to the contrast between the AGRA assumptions and parameters with the three parameters that are identified that could be useful in formulating food security policies and research and development goals. The missing relations between agroecology (nature) and socio-economic (culture) parameters and the potential dangerous consequences of AGRA-type recommendations are revisited in relation to eight major critiques. The chapter ends by proposing alternative sets of agroecological, plant genetic and socio-cultural and economic parameters that may be useful for orienting policies and goals that aim at improving traditional agroecological systems and ensuring food security in Africa. Policy recommendations and suggestions for further research are also made.

CHAPTER TWO
THE RESEARCH CONTEXT AND RATIONALE

2.1 Introduction

This chapter provides a brief overview of the nature and importance of cassava production across the globe, and a general outline of the policies, goals, assumptions, and research orientations that guide the promotion of cassava as a crop, industrial input, and foodstuff in developing regions, with a special emphasis on Cameroon and on the two regions within it that are the focus of this dissertation. It begins by discussing the importance of the crop in developing countries (which are the major producing areas), in Cameroon, and in the study area. It focuses on the general understanding of cassava's importance in terms of agroecological qualities, production trends, use values, domestic consumption, and markets (domestic and trade). It situates cassava in relation to food security and income in Cameroon and the study area and briefly mentions the cultural, spiritual, and medicinal values associated with cassava in Koudandeng that are discussed in-depth in Chapter 6.

The second section discusses the Cameroon Government's policies, goals, and research orientation, and compares and contrasts these with the goals, assumptions, and modalities of implementation of the Alliance for a Green Revolution in Africa (AGRA) and of the CGIAR institutions that deal with cassava (IITA Nigeria and CIAT Columbia). Some of the factors that have influenced the development of each policy, goal, and orientation are also discussed. It ends with a brief discussion of the characteristics and dynamics of cassava production, processing, and marketing in Cameroon in general, and in Malende and Koudandeng in particular.

The third section presents the main arguments made in the dissertation with regard to the assumptions and lacunae in the current sets of policies and practices that are examined through research into the cultural, economic, and agroecological dynamics of Malende and Koudandeng. It is argued that Malende and Koudandeng represent an adequate empirical basis for examining the relevance of the goals, the validity of the assumptions, and the appropriateness of the modes of implementation of Cameroon Government, AGRA, and the CGIAR policies and programmes.

The fourth section presents essential comparative information on the study site populations of Koudandeng and Malende villages, including their access to cassava markets, production resources, cassava HYVs, and research and extension services; their agroecological potential for cassava production; the orientation of cassava production, degree of adherence to cultural traditions, and demographics, including household HIV/AIDS status.

2.2 The Cassava Cultivar: Global to Local Importance

Cassava is believed to have originated in tropical equatorial regions of South America (Vavilov, 1939, 1951; Smith, 1968; Ng and Ng, 2002) where its domestication dates from 3000-7000 years ago (Sauer, 1952; Smith, 1968; Ugent et al., 1986; Ng and Ng, 2002). Rogers (1965) and Ng and Ng (2002) also made a case for the Mesoamerican countries as potential areas of early domestication. Brucher (1989) and Ng and Ng (2002) reported that people of the Arawak tribes of Central Brazil were responsible for diffusing cassava from South America to the Caribbean Islands and Central America in the 11th century. Its spread from South America to other parts of the world was ensured by the arrival of the early European explorers. Cassava flour was used as a provision for ships plying between Africa, Europe, and Brazil. The first mention of cassava cultivation in Africa dates back to 1558. At first, it was cultivated with the sole purpose of provisioning slave ships, until about 1600. Jones (1959) reported that the Portuguese transported cassava to the Coast of Central Africa through the Gulf of Benin and the Congo River at the end of the 16th Century. Toward the end of the 18th Century, it then spread to the East Coast of Africa through the islands of Reunion, Madagascar, and Zanzibar (Barnes, 1975; Jennings, 1995; Ng and Ng, 2002). Between the 18th and 19th centuries, cassava was introduced into Asia through India, Java, and the Philippines (Ng and Ng, 2002; Onwueme, 2002) and the Spaniards introduced it to the Pacific (Jennings, 1995; Ng and Ng 2002). Jennings and Iglesias (2002) hold that, even though cassava has been evolving as a food crop since the second and third millennia BC, its adaptation to African and Asian conditions did not begin until post-Colombian times.

The above suggests that cassava is a complex species that has various initial sites of cultivation. It is now widely cultivated in the tropics where it provides the major source of food for about half a billion people in Africa, Latin America, and Asia (Ng and Ng, 2002; Balagopalan, 2002; Henry and Hershey, 2002). As will be discussed in the sections that follow, cassava not only serves as a source of food for humans; it is also a major industrial crop that provides starch for various pharmaceutical and fast food industries, and a major livestock feed sold in the form of pellets and residues, which generates substantial revenues. There is a growing recognition of the importance of cassava as a staple crop and its role in the fight against hunger and poverty, and as an export commodity and thus foreign exchange generator for developing countries (Prakash, 2007).

2.2.1 The Importance of Cassava in Developing Countries

The importance of cassava lies on the fact that its agroecological traits and various forms of utilisation and market outlets gives it comparative advantage over other root and tuber and cereal crops in many developing regions, especially in the tropics.

2.2.1.1 Agroecological importance

In relation to its agroecological advantages, cassava is described as a hardy crop because it grows well under harsh climatic and environmental conditions (Henry and Hershey, 2002; Leihner, 2002; Howeler, 2002; Hillocks and Wydra, 2002; Onwueme, 2002) and as a crop that is advantageous for small farmers because:

- It can be grown in low input production systems that use little or no fertiliser;
- Compared to other food crops, it requires little labour and input investment once the crop is fully established;
- It is exceptionally tolerant to drought and water stress;
- It is tolerant of poor soil conditions such as low pH, aluminium toxicity (high levels of exchangeable aluminium) and low concentrations of phosphorus. Thus, it is tolerant to infertile soils and produces reasonable yields on eroded and degraded soils where other crops would fail;
- It is propagated vegetatively through stem cuttings or stakes, and it is thus easy to obtain plant material from farmers' own or neighbour's fields;
- It provides an efficient source of carbohydrates when grown under optimal and sub-optimal conditions;
- It has a long growth cycle (eight to 24 months) compared with cereal and legume crops;
- Cultivars or varieties exhibit considerable variation in susceptibility to pests and diseases;
- It is highly compatible with various types of intercrops and flexible as to the time of harvest; therefore its cropping systems vary widely and include both monoculture and polycultures;
- It has the potential to adapt to a wide range of ecosystems in the tropical countries.

Henry and Hershey (2002) reported that these traits have combined to make cassava a significant sustaining force for the poor in the tropics. While it is grown widely, production statistics vary across the major producing areas. Table 2.1 highlights the scale of production, yield per unit area, and storage root production statistics for the major production regions of the world.

The data in Table 2.1 suggest that, even though cassava originated in Latin America, Africa is the largest cassava producer in terms of surface area cultivated and production, and cultivates over 50% of the global crop. Asia ranks second to Africa, while Latin America and the Caribbean rank third. Despite the large surface area cultivated and the high volume of production, its yield potential in Africa is lower than the global average. In terms of yield, Africa ranks third to Asia and Latin America and the Caribbean, which may be due to the fact that cassava is grown mostly in polyculture in Africa. Onwueme (2002) notes that the wide variation in cassava yields within Asia is determined by cropping systems and production conditions. The regional statistics provided tend to obscure production realities at country level. Prakash (2007) reports that around 60% of global cassava production is concentrated in five countries: Nigeria, Brazil, Thailand, Indonesia, and the Democratic Republic of Congo (formerly Zaire).

Despite the high agroecological potentials of cassava that gives it competitive advantage over other crops, the high perishability of the harvested fresh roots means that it requires processing to extend utility and add value. Processing requires high labour investments. Fresco (1993) and Fregene and Puonti-Kaerlas (2002) note that the relatively low inputs required for primary cassava production contrast sharply with the high inputs and risks involved in processing, transportation, and marketing of the highly perishable roots. The bitter cassava varieties require processing to reduce the toxicity levels caused by their high cyanide content. Low cyanide content (less toxic) varieties do not necessarily require processing.

Table 2.1 Regional Trends in Surface Area Cultivated, Production, and Yield of Cassava (1970 to 2005)

Production	*Region/World*	*Statistics*					
		1970	*1980*	*1990*	*2000*	*2004*	*2005*
Surface Area (000 ha)	World	11615	13556	15605	16884	18475	18696
	Africa	6486	7035	8982	10907	12252	12354
	Latin America and the Caribbean	2403	2471	2438	2281	2696	2649
	Asia	2485	3803	3941	3468	3511	3429
Production (000 mt)	World	97558	123796	155127	178009	203618	203341
	Africa	39231	48492	71769	96988	108470	109755
	Latin America and the Caribbean	32022	27668	28792	28258	34727	34094
	Asia	23102	44419	51689	49937	60245	56082
Yield (hg ha^{-1})	World	84	91	99	105	11.02	109
	Africa	60	70	80	89	8.85	89
	Latin America and the Caribbean	121	102	107	113	12.88	117
	Asia	93	117	131	144	17.16	164

Source: adapted from Howeler, 2006; FAOSTAT, 2006 and Prakash, 2007.

2.2.1.2 Use values

The agroecological potentials of cassava have received greater attention in scientific discourse relative to its processing and other use values and marketing opportunities. Even when cassava's use values are considered in development policies and projects, emphasis is placed on the different processed forms and markets, while neglecting other use values that traditional and small-scale producers view as important. Cassava has diverse use values that range from food for humans to economic, animal feed, pharmaceutical/medicinal, cultural, and spiritual values. Westby (2002) stresses that the importance of cassava in the world is mainly a reflection of its agronomic advantages, and argues that increasing cassava's contribution to the livelihoods of poor people will require a consideration of postharvest handling, processing, and marketing. To this I would add that it is important to give greater consideration to the medicinal, social, cultural, and spiritual values of cassava that are entwined in the livelihoods of most producers in developing countries.

While cassava is grown in the tropics, it is used worldwide in diverse forms. It is the primary staple for some tropical and sub-tropical nations (especially in Africa and Asia), and it is used as a main carbohydrate source in animal feed and as a raw material in the manufacture of processed food, animal feed, and industrial products (Balagopalan, 2002). Both fresh storage roots and leaves/young plant tips have multiple end uses that include: i) direct human consumption, ii) on-farm feeding of animals and commercial production of animal feed; iii) production of starch and starch derivatives; iv) production of ethanol for use as a biofuel (automotive fuel) or in alcohol production; v) compost; and vi) mushroom production. In relation to direct human consumption, the forms in which cassava is eaten in Africa include: boiled fresh roots, cassava flours (fermented, unfermented), granulated roasted cassava paste called gari (aka tapioca), granulated cooked cassava (attleke, kwosal), fermented pastes (water fufu, chikangwa, couscous), sedimented starches, drinks, leaves (cooked as vegetables) and medicine (Hillocks, 2002). Farhina is also eaten mostly in Latin America and the Caribbean. Cassava is an important source of carbohydrates.

Commercial animal feed is produced from cassava chips, pellets, pulp, peels, root and leaf silage, and root powder (Balagopalan, 2002; Howeler, 2006). In order of importance, cassava ranks fourth as the main source of industrial starch production after maize, wheat, and potato (Henry and Westby, 2000). Industrial cassava products include: starch, modified starch, sweeteners, alcohol, organic acids and amino acids, and derivatives. These serve in the manufacture of processed food, paper, plywood, textiles, pharmaceuticals and biodegradable plastics. Cassava starch products are consumed directly in the form of sago pearls, noodles, and traditional desserts. Modified starch derivatives include: i) acetylated starches used in sauces, frozen foods, instant soups, pastries and glues; ii) cross linked and oxidised starches used in salad dressings, canned food, sauces, candies, paper and textiles; and iii) cationic starch that is used for paper and textile manufacture. Sweeteners include: i) glucose/dextrose used in candies, beverages, canned food, medicine and creamers; ii) fructose (high syrup) used in beverages, pastries, desserts, candies and sauces; and iii) sorbitol used to manufacture toothpaste, cosmetics and vitamin C. The main cassava starch-derived alcohol is ethanol, which is used as liquor, medicinal alcohol or industrial fuel (biofuel). Cassava-based organic acids include: citric acid, acetic acid, lactic acid, and itaconic acid that are used in the food industry and for the production of plastics, synthetic resins, and rubber products. Cassava-based amino acids and their derivatives include: monosodium glutamate (MSG), used as a flavour enhancing agent in Asian cuisine, and lysine, used as a food supplement in animal feed. Table 2.2 highlights the proportion of total cassava production that is used in specific ways by major cassava producing regions of the world.

Table 2.2 Percent Total Cassava Production Consumed Domestically by Major Production Regions

Product	*Region*	*% Quantity of total production used*				
		1970	*1980*	*1990*	*2000*	*2004*
Food	World	57	54.5	53.2	55.6	51.4
	Africa	71.3	72.4	69.5	64.6	60.9
	Latin America and the Caribbean	39.3	40.2	39.6	41.9	34
	Asia and the Pacific	63.8	44.6	41	49	44.4
Feed	World	28.6	33.2	35.2	27	25
	Africa	13.4	11.9	13.5	16.5	16.2
	Latin America and the Caribbean	52.1	51.7	52.4	49.9	43.9
	Asia and the Pacific	7.5	10	12.4	13.6	20.1
Industrial use (starch and others)	World	3.5	2.3	2.5	4.0	6.2
	Africa					
	Latin America and the Caribbean	7.1	6.9	6.6	5.4	5.5
	Asia and the Pacific	3.9	1.8	3.1	8.7	14.1

Source: Calculated based on data from Howeler, 2006; FAOSTAT, 2006; and Prakash, 2007.

Until 2004, cassava was mainly grown in Africa for food and to a lesser extent for animal feed, but the percentage destined for other uses increased steadily over time. In 2004, only about 60% of Africa's cassava production was consumed as food. The production of starch and other starch derivatives in Africa is insignificant compared to Asia and the Pacific and Latin America and the Caribbean. According to Henry and Westby (2000), FAO (2000), and Henry (2000), starch production in Africa is probably managed for local consumption, but the availability of data is limited. Cassava is now being used to partially substitute wheat flour in Africa. Of the few cassava starch factories that existed in Uganda, Tanzania, and Madagascar in the 1970s, only a few are operational to date and little information exists on their production status. Starch production in Africa in recent years may be limited to specific countries such as Malawi, Uganda, Zimbabwe, Ghana, Nigeria, Kenya, and the Democratic Republic of Congo.

In Latin America and the Caribbean, about 50% of cassava production is destined for use as animal feed, 40% for food and less than 10% is for industrial use at local level (Table 2.2). Henry and Westby (2000) note that cassava starch factories in Latin America are small scale, especially in Brazil, with a few large-scale factories in Venezuela.

In the Asia and Pacific region, less than 50% of cassava production is consumed locally as food whereas less than 20% is either used for animal feed or in industries. Phillips (2009)[1] noted that, in Africa and Asia, cassava is primarily used for food and in industries, whereas in Central and South America, animal feed accounts for 50% of cassava utilisation. China, Thailand, Indonesia, and Vietnam are the major Asian countries that process cassava at industrial level.

2.2.1.3 Cassava trade

The global economic importance of cassava lies in the fact that it has both domestic and export markets. Phillips (2009) noted that 75% of global cassava production is consumed locally. The data in Table 2.2 show that, as of 2004, 77% of Africa's total cassava production was consumed locally, while Latin America and the Caribbean consumed 83.4% of total production and Asia and the Pacific consumed 78.6%. On a regional basis, the domestic markets for cassava vary by type of product. For example, Africa's domestic markets are mainly centred on food and cassava is sold either as fresh roots or in processed forms. Asia's domestic cassava market is more oriented towards industrial processing and feed manufacture.

Cassava has been a major export commodity since the 17^{th} century when it was especially traded between South America and Europe (Henry and Hershey, 2002). Phillips (2009) noted that the primary cassava trade commodities up to the 1950s were starch and flour, whereas chopped roots, chips, and pellets joined the international market in the mid-sixties as a result of the increased demand for cheap imported protein and energy rich food sources in the animal feed industries of Europe. This demand was to counter the soaring prices of grain that occurred as a consequence of the establishment of the Common Agricultural Policy (CAP) for the European Union in 1963. The countries involved in cassava exports in the 1960s were Thailand, Indonesia, and Malaysia, Cote d'Ivoire, and Brazil. From the 1990s onward, starch and tapioca have become important export commodities in all three major producing regions. Fresh and frozen roots are mainly exported by Costa Rica. Asia not only maintains its leading role in the cassava export market, but has also become the major importer of cassava and cassava derivatives in the world. At Present, Thailand is the largest exporter and therefore has become the price setter in the world cassava market, which implies that any producing country must be competitive with Thailand in order to be successful in

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[1]Phillips, T.P. 2009. The market for cassava in the world. Prepared for the XIII Congresso Brasileiro de Manioca. dTp Studies Inc. Report DTP 8/5/2009. Clifford, Ontario, Canada.

exports (Ibid.). The export market for Africa's cassava products is mostly informal, and most trade occurs within the region.

In terms of imports, world trade in cassava accounted for not more than 25% of the total world production in 1989 (Phillips, 2009). Trade in cassava had grown from a thousand tones in 1961 to 12 million tones in 1989 and, since 1995, volume has stabilised at seven million tones annually with an equivalent monetary value of US$700 million. According to the FAO (2000), international trade in cassava products since the 1960s mainly consisted of animal feed where, between 1973 and 1985, the European Union and the rest of the developed world consumed about 23000 million tonnes each. The amount of feed consumed grew at an annual average of about 11% from 1973 to 1985. Within the EU, the largest markets for cassava pellets were the Netherlands, Belgium, Germany, Spain, and Portugal. From 1995 onwards, dried cassava, cassava starch, and tapioca have gained ground as the major cassava export commodities with Asia being the major exporting region. Africa ranks second to Asia in the export of cassava flour, whereas South America ranks second to Asia in the export of tapioca and starch. According to the FAO (Ibid.), the demand for cassava as feed dropped following the decline in cereal prices in the European Community as a result of the 1992 reform of the Common Agricultural Policy (CAP), which provided incentives for the utilisation of grains by the feed industry.

More recently, large markets for cassava include: Europe (Netherlands, Belgium, Germany, Spain, Portugal, France, Russia, Sweden and the United Kingdom), North America (Canada and USA), Central America and the Caribbean (Aruba), South Africa, and Asia. As of 2005, Asia has become the leading cassava importer, with China being the largest importer in the world (Phillips, 2009). This may be due to the growing ethanol, food, and pharmaceutical industries in China. Asian cassava imports are supplied by Asian countries rather than by other producing regions. Howeler (2006) and the FAO (2006) present statistics on cassava chip and pellet imports for 2004 as follows: total world imports: 667,2000 tonnes, USA imports 58,000 tonnes, European Union imports 2,602,000 tonnes and Asia imports 3,995,000 tonnes. Phillips (2009) highlights that, in 2005, the major outlet for cassava in the world was starch that was imported to the value of USD $350 million. Dried cassava ($55 million) follows in second position and tapioca ($18 million), which is an important processed product in Africa, follows in third position. Within the African continent, only South Africa imported cassava starch in 2005.

2.2.2 Cassava in Cameroon

Cassava spread from the eastern parts of the Republic of Congo along the Sangha River through Yokadouma in East Cameroon between the 19th and 20th centuries (Mouton, 1949; Jones, 1959; Ambe, 1994, Nchang Ntumngia, 1997). The existence of cassava among the Fulani in the northern parts of Cameroon was noted by Bath (a German traveller) in 1850 (Rossel, 1987 cited in Nchang Ntumngia, 1997). In relation to its agroecological potentials, Ambe (1994) and Nchang Ntumngia (1997) have noted that, even though cassava is exotic to Cameroon, it is grown in all of its 10 provinces because of its ability to thrive in altitudes ranging from 0-1800m above sea level with wide climatic variations and diverse agroecological conditions. Cameroon has five major agroecological zones:

- Zone I: Soudano-Sahelian zone (comprises of Far North and North Provinces);
- Zone II: Guinea Savannah zone or the Adamawa Plateau (Adamawa or Adamaoua Province);
- Zone III: Western High Plateau or Highlands (West and Northwest Provinces);
- Zone IV: Coastal Lowlands or Monomodal Rainfall Humid Forest zone (Southwest and Littoral provinces);
- Zone V: South Cameroon Plateau or Bimodal Rainfall Humid Forest zone (Centre, East and South Provinces).

While cassava thrives in the entire territory, its production and importance varies by agroecological zone. Some 78% of national production is obtained from the Coastal Lowlands, or Zone IV (27%) and the South Cameroon Plateau, or Zone V (57%), whereas the Western Highlands or Plateau produces 15%, the Adamawa Plateau produces about seven percent, and the Soudano-Sahelian zone produces less than one percent (MINADER, 2003a). In terms of the surface area cultivated in food crops, cassava-based farming systems occupy 43% of total surface area in Zone II, four percent in Zone III, a quarter in Zone IV, and 30% in Zone V. As will be discussed below and in Chapter 4, cassava is traditionally cultivated mostly in polyculture in all agroecological zones.

2.2.2.1 Cassava and food security

Cassava falls within the category of root and tuber crops. MINADER (Ibid.) shows that, in the 1999/2000 crop year, root and tuber crops contributed about 50% (3.5 million tonnes) of total food crop production in Cameroon, of which cassava contributed 54% (1.9 million tonnes). Cassava's contribution to total national food crop production is shown in Table 2.3.

Closer examination of the data in Table 2.3 shows that root and tuber crops provide 43% of total annual food crop production in Cameroon while plantain and banana provide 21%, cereals provide 20%, and oil seeds and pulses provide eight percent. Therefore, cereal production ranks third after roots and tubers and plantain/banana.

In relation to root and tuber crop production, cassava ranks first and constitutes 55.5% of this category, closely followed by cocoyam and taro, which provide 28.3%; yams constitute seven and a half percent, sweet potato five percent, and Irish potatoes constitute less than four percent. In terms of total national food crop production, cassava thus constitutes 24%, ranking as first among all the food crops produced. In terms of cassava production in Africa in 1998, Cameroon ranked tenth, following the Democratic Republic of Congo, Nigeria, Ghana, Tanzania, Mozambique, Angola, Madagascar, Uganda, and Côte d'Ivoire in this order (FAO, 1998; Hillocks, 2002).

Cassava constitutes the main source of energy, especially in the major producing regions (agroecological zones IV and V), and constitutes a food security crop in the three other zones. Ambe (1994) and Nchang Ntumngia (1997) showed that it is the main energy source in the forest regions of Cameroon and that it provides more than 30% of total calorie intake. Among all the major energy-providing crops (cassava, yam, cocoyam, colocasia, sweet potato, plantain, Irish potato) that are grown in Cameroon, it ranks first in per capita consumption. According to FAOSTAT (2008), the per capita consumption of cassava in 2005 in Cameroon was 90.13 kg/year, where cassava provided on average 270.87 kcal/capita/day, which are higher than was estimated in 2002, at 75kg/person (MINADER, 2003b). Of the two million tonnes produced that year (Table 2.3), it was estimated that 1.1 million tonnes were consumed in total: 360 tonnes in urban and 770 tonnes in rural areas.

Table 2.3 Production Statistics for Some Food Crops in Cameroon (2002 to 2005)

Food Crop Group	*Crop*	*Annual Production Statistics (tonnes)*			
		2002	*2003*	*2004*	*2005*
Oil seeds and pulses	Groundnut	210712	218087	225720	253953
	Egusi	127429	743466	124997	129373
	Sesame	3157	3267	3382	3630
	Voandzou	9082	9391	9711	17979
	Melon (pumpkin or squash)	36820	37961	39138	40351
	Palm oil	153121	162308	172047	215290
Sub total oil seeds and pulses		540321	1174480	574995	660576
Cereals/grain crops	Maize	861456	912281	966106	1178921
	Millet and sorghum	541975	573951	607814	764485
	Rice	44546	47145	49958	84197
	Soy bean	6295	6515	6743	7113
	Bean	186940	193296	199868	264795
Sub total cereals and grains		1641212	1733188	1830489	2299511
Root and tuber crops	Yam	274292	280326	286494	372524
	Cocoyam/colocasia (taro)	1079533	1103282	1127555	1240037
	Cassava	2003643	2047714	2092763	2776787
	Sweet potato	181976	185980	190071	242481
	Irish potato (*Solanum tuberosum*)	136342	139341	142407	177817
Sub total roots and tubers		3675786	3756643	3839290	4809646
Plantain/banana	Plantain	1237014	1275362	1314898	1670686
	Banana	692886	743466	797739	815375
Sub total plantain/banana		1929900	2018828	2112637	2486061
Food Crop Group	*Crop*	*Annual Production Statistics (tonnes)*			
		2002	*2003*	*2004*	*2005*
Vegetables	Tomato	389160	398500	408064	639874
	Okra	34120	34938	35777	36292
	Onion	70303	71990	73713	111838
	Cabbage	-	-	-	186080
	Pepper	7287	7942	8657	15209
Sub total fruit vegetables		500870	513370	526211	989293
Fruits	Pineapple	45555	46968	48424	100139
	Watermelon	29388	30299	31238	34582
Sub total fruits		74943	77267	79662	134721

Source: National Institute of Statistics, 2008. NB: the data in Table 2.5 does not include green leafy vegetables and most fruits.

Cassava is eaten either fresh (boiled, raw) or processed. The quantity of each cassava product consumed varies by region, level of urbanisation, and ethnic diversity of the dwellers and their diverse food habits. For example, baton (bobolo, ndeng) and couscous (nkum-nkum or flour) and cassava alcoholic drinks or spirits (meungwalla) are the major cassava processed forms in agroecological Zone V where cassava is the main staple. Water fufu and gari (also called aka tapioca) are mainly processed in Anglophone Cameroon (Southwest Province located in agroecological Zone IV and, to a lesser extent, in the Northwest Province which is located in agroecological Zone III). Miondo is mainly processed in the Littoral Province, which is part of agroecological Zone IV. Cassava is also processed into beigner (or makra) and starch, which are considered as minor products compared to the other cassava products. Fresh cassava roots are generally boiled and eaten with a relish, or boiled, pounded, and eaten with a relish, or eaten raw. Cassava leaves are also eaten in the two major producing regions.

For example, Dury's (2001) study of the value of the consumption of starchy products in four southern cities in Cameroon presented the statistics in Table 2.4. The data in this table show that the consumption of cassava products in high for Yaounde and Douala, which are the major cities of Cameroon and therefore more densely populated compared to Ebolowa and Mbalmayo. In terms of the different cassava products consumed, miondo is mainly processed and consumed in Douala. Baton, fresh storage roots and water fufu and foufou are the most consumed forms of cassava in Douala and Yaounde, which reflects the ethnic diversity and diverse food habits of these major cities. Douala is the economic capital, while Yaounde is the administrative capital of Cameroon and they are bound to have substantial ethnic diversity.

Table 2.4 Value of Household Consumption of Cassava Products in Four Cities in Agroecological Zones IV and V in Cameroon (1999-2000)

Cassava Product	*Value of products consumed in the four cities (million F.cfa/year)*				
	Cities of Agroecological zone V			*Agroecological zone IV*	Total
	Yaounde	*Ebolowa*	*Mbalmayo*	*Douala*	
Cassava fresh roots	2419	90	94	2948	5551
Baton (ndeng, bobolo)	2007	90	49	3700	5846
Miondo (myondo)	-	-	-	1108	1108
Gari (tapioca)	416	16	28	615	1075
Water fufu/foufou	1109	50	37	2600	3796
Other Products	45	-	-	74	119

Source: Adapted from Dury, 2001. NB: This table does not include couscous (cassava flour) and leaves.

2.2.2.2 Cassava and income

Cassava is not only grown for food, but also constitutes an important source of income for farm households, processors, and petty traders in Cameroon. It is sold for domestic consumption and for export. According to MINADER (2003b), cassava prices in local and urban markets have been on the increase since 1994, when the F.CFA was devalued, which highlights growing demand for cassava within the country. Between 1994 and 2001, domestic prices for cassava and its products had risen by 15% but, by 2007, prices had risen by 310% (from US$59.81 to US$177.54 per tonne) (FAOSTAT, 2008). Phillips (2009) classified Cameroon as one of the major cassava producing countries where the domestic price of cassava is above US$100/mt, arguing that high prices for cassava mostly reflect the country's population growth and increasing per capita demand for cassava and cassava products.

Regional trade in cassava and cassava products between Cameroon and the neighbouring countries of Central Africa (Gabon, Equatorial Guinea) and the West African (Nigeria) regions is mostly informal due to the lack of appropriate structures to control and document trade in agricultural commodities, which limits the availability of trade statistics. The National Institute of Statistics (2008) in 2005 indicated that 495 tonnes of processed cassava products were exported as follows:

- 151.55 tonnes of cassava flour (142.05t to Gabon, 9.5t to Equatorial Guinea);
- 57.2t of gari (tapioca), to Nigeria;
- 249.57t of baton (246t to Gabon, 3.57t to Equatorial Guinea).

Fresh cassava roots are not exported because of the high level of perishability and the non-existence of the preservation methods (paraffin) that are used, for example, in Costa Rica. Land transport is the main means by which agricultural export commodities, including cassava, are traded between Cameroon and these countries. In relation to imports, according to the National Institute of Statistics (2008), Cameroon imported 440t and 717t of starch by sea in 1999/2000 and 2000/2001, respectively, but these statistics do not indicate the type of starch in terms of crop from which it is derived, nor the exporting country.

2.2.3 Cassava in Malende and Koudandeng

Above, it was noted that 78% of total cassava production in Cameroon is produced in agroecological zones V and IV, which fall within the humid tropical forest region. Koudandeng falls within agroecological zone V with bimodal rainfall patterns, whereas Malende falls within agroecological zone IV with semi-bimodal rainfall patterns. Koudandeng and Malende lie in Cameroon's highest cassava producing region, or 'belt'. These two villages are characterised not only by high cassava production, but as well are located in semi-urban areas or urban peripheries, so that cassava production is greatly influenced by the urban markets of the capitol city of Yaounde, in the case of Koudandeng, and Buea, Tiko, Limbe, and Douala, in the case of Malende. While Malende's cassava production is largely commercially oriented, Koudandeng is more subsistence oriented. Comparison between the two villages therefore may provide insights into the impact of processes of commoditisation and government policy on cassava breeding and dissemination, management, agroecological production systems, food security, nutrition, and livelihoods and income for farm households. Section 2.5 presents a detailed discussion on the suitability of this study area for this research.

2.2.3.1 Cassava in Malende

Of all of the food crops grown in the Southwest Province to which Malende belongs, which includes the capital of Buea and Muyuka and other large urban and rural centres, cassava ranks second only to plantain in terms of surface area cultivated and quantity produced. In 2009, cassava-based farming systems occupied 3060 ha of the total land area cultivated with annual food crops and contributed 36% of total food crop production in the province. In Fako Division, cassava-based farming systems cover 26% of the total surface area cultivated with food crops (MINADER-NAERP, 2007). Cassava ranks first in terms of total production among all the food crops grown, but it is second to plantain in terms of total surface area cultivated. Within Fako Division, the Muyuka Sub-division, to which Malende belongs, produces over 50% of the total cassava in this Division.

A census of cassava producing households that I carried out in Malende and Koudandeng in 2003 showed that both men and women grow cassava (Nchang Ntumngia, 1997). An average Malende farmer grows three to four cassava varieties that fall into two main groups of cultivars: bitter and sweet. A detailed discussion about the number of varieties managed and the reasons for managing cassava diversity is given in Chapter 5. Compared to Koudandeng, improved high yielding cassava varieties are grown more in this peri-urban village, and production is more commercially oriented. As will be discussed in the section on farming systems below and in Chapter 4, cassava is mostly grown in polyculture in Malende.

Even though farmers in Malende principally sell cassava, it is also grown for own consumption. It is eaten either fresh or in processed forms; fresh roots are either boiled and eaten with a relish, or boiled and pounded into fufu, which is eaten with a relish. The processed cassava forms include gari, water fufu, and miondo. One or two households process makra and nkum-nkum (cassava flour). Except for makra, which is eaten as a snack either with spiced pepper or alone, all of the other cassava forms are eaten with a relish, which can be made of vegetables or animal and fish proteins. The most common vegetable that is eaten with cassava is eruh (*Gnetum africanum*), a wild food plant that is harvested from the forest. The different traditional cassava dishes and processing methods are discussed in relation to foodways and varietal diversity in Chapter 6.

While cassava is commonly eaten in Malende, it is not a staple crop, and a greater volume is sold than consumed. The cassava household census carried out in 2003 indicated that 81% of the cassava grown in Malende is sold, where 86% of households sell gari, 35% sell fresh roots, and 13% sell water fufu. The average annual income from cassava in Malende in 2003 was 895,000 F.cfa (US$ 1690). For individual farmers, gari provided the greatest annual income per year (8,100,000 F.cfa - US$ 4793), earned by a man who sells 100% of the cassava produced, closely followed by raw water fufu (2,275,000 F.cfa - US$ 1346) and cooked water fufu (1,248,000 F.cfa - US$ 738), but the average income from water fufu is 838,000 F.cfa (US$ 495), and for gari it is nearly the same: 820,000 F.cfa (US$ 485). At the provincial level, cassava sales contributed 20.8% of the total household income obtained from sales of food crops (fruit excluded) in the Southwest Province and for 28% of total household income from food crop sales (fruits excluded) in Fako Division in 2007 (MINADER-NAERP, 2007).

There are various cassava markets in Malende: farm gate sales (harvested roots sold in truckloads or in heaps, sales of standing plants as portions of fields, sales of plant material); ii) home-based sales (raw water fufu, harvested roots sold in heaps or truckloads, retailed gari); iii) village restaurants and vendors (cooked water fufu); iv) sales in the village and in neighbouring towns (gari, harvested roots in heaps and push truck loads, raw water fufu, miondo). Women dominate sales in village restaurants as well as wholesale and retail sales in village markets and the suburban market of Muyuka, while men dominate farm gate sales and gari wholesaling in the town markets of Limbe, Tiko, and Douala. The mobility of Malende women is more limited compared to that of men, which affects their access to markets. The sale of cooked water fufu to be eaten with eruh or okra soup in home-based restaurants is an important market niche that is exploited by a few women who receive an average annual income of 992,000 F.cfa (US$ 587).

The frequency of sales of each cassava form varies according to individual household needs. However, the general pattern is such that retailing of gari and water fufu and restaurant and vendor sales of cooked cassava products are done on a daily basis, whereas sales in the other market locations are weekly and based on the traditional market calendar. Sales in neighbouring town markets do not follow this weekly calendar but depend on individual household needs. Apart from sales within local markets, trade in cassava and cassava products between Malende and the neighbouring countries of Gabon and Equatorial Guinea exists but is mainly informal. It is therefore difficult to estimate the quantity and monetary value of the different forms of cassava that are exported from Malende.

2.2.3.2 Cassava in Koudandeng

All 116 households in Koudandeng produce cassava. The census carried out in 2002–2003 showed that farmers manage a greater diversity of cassava varieties (28 in total) relative to Malende (16 in total), with an average Koudandeng farmer growing between five and eight varieties. Farmers in Koudandeng grow more sweet (24) than bitter (four) varieties. Cassava is the main staple crop and is mostly eaten boiled with a vegetable relish (most often cassava leaves called *kwem*), which helps to explain the greater diversity of sweet varieties. Cassava is mostly grown in polyculture. Traditionally, as in much of the rest of Cameroon, it is a women's crop and women's main food crop fields are based on a cassava-groundnut association. Detailed discussions of traditional farming systems in Koudandeng are presented below and in Chapter 4.

Fresh cassava roots and leaves are eaten. Households eat about 65.5% of the total cassava produced (roots and leaves). Fresh roots are boiled and eaten or processed into batôn (locally called ndeng), couscous (cassava flour or nkum-nkum or vouvou in the local language), masoma (wet chips), meungwalla, and beigner. Only one household processes starch for clothing. Beigner is eaten as a snack either with spiced pepper sauce or alone, while boiled cassava roots, couscous, and baton are eaten with vegetable or animal and fish protein relishes. The main vegetable relish, called *kwem*, consists of pounded cassava leaves. *Meungwalla* is a high alcohol content drink distilled from a mixture of cassava and maize.

Both cassava storage roots and leaves are sold. According to the 2003 census, 79% of households sell cassava roots and only 15.5% sell the leaves; 34.5% of the total village harvest is sold. Unlike Malende, where average annual household income from cassava is high, it is about 174,172 F.cfa (US$ 328) in Koudandeng. The main forms sold are fresh roots, baton, and couscous. Meungwalla sales are being replaced by imported gin, while only a few households sell beigner.

While cassava marketing in Malende is mainly localised within the village and in Muyuka, Koudandeng farmers mainly sell cassava in external markets. Apart from sales of standing plants at farm gate, fresh roots, baton, and couscous are sold in the urban peripheral markets of Obala and Nkometou, and in the urban markets of Yaounde. Compared to Malende, where women's mobility in cassava sales is limited to the village and to the suburban market of Muyuka, Koudandeng women seem to have greater mobility and are able to sell in more distant urban markets.

The frequency of cassava sales depends on the needs of individuals and households and, unlike Malende, where individual households more frequently sell cassava and cassava products, cassava sales in Koudandeng are irregular. Sales outside of the village mainly occur at weekends: Saturdays for sales in Obala and Yaounde, and Sundays for sales in Nkometou. Only a few households sell cassava on a weekly basis, and the general pattern is such that households sell cassava every two to three months, according to their needs. Households that sell cassava twice a year often say that they do not sell cassava at all. Generally, cassava sales are strong during festive periods (Christmas, New Year, political events such as the national party celebration and International Women's Day) and at the beginning of the academic year (August to October) when expenses are high. There is informal regional trade in baton between Koudandeng, Gabon, and the Republic of Congo (countries neighbouring Cameroon), where market intermediaries either buy baton directly from the villagers through farmer groups, or individual farmers deliver it to specific market intermediaries in Yaounde.

While the importance of cassava is viewed in terms of its food and economic value, cultural, spiritual, and medicinal values are also of importance to farm households, especially in Koudandeng, where cassava is the main staple. Chapter 6 provides a detailed discussion of these values.

2.3 Cassava Policies: From Local to Global

Given the significance of cassava outlined in the first sections, its promotion and improvement is the subject of intensive policy and programming efforts, from local to global levels. These policies, and their related programmes, are the subject of scrutiny in this dissertation. Global and regional policies have substantial influence on local policies, particularly as these are formulated, translated, and implemented through organisations that focus on the crop, such as those of the CGIAR system.

2.3.1 Cameroon Government Cassava Policies, Goals, and Research Orientation

In the early 1980s, based in part on FAO's 1979 goal of 'Food for All", which exhorted developing countries to urgently increase their foreign exchange earnings particularly in order to overcome the rapidly mounting burden of external debt, the Cameroon Government adopted the policy goal of attaining food self-sufficiency by the end of the decade. This policy focused on increased food production and was to be achieved through a multi-disciplinary approach that sought means to revitalise various economic activities, including agriculture. Agriculture was viewed as the driving force behind Cameroon's economic development, with greater emphasis to be placed on increasing the production of export crops such as cocoa, cotton, coffee, rice, groundnut, oil palm, and rubber, which provided a greater portion of its total exports. Despite this policy, since 1985, Cameroon has faced decreases in the value of its export crops due to the failure of developed importing nations to respect international trade agreements between producer and consumer countries. This resulted in an accumulation of huge stocks and of farmers' debt that, together with the application of the Structural Adjustment Programme required by the IMF, led to the devaluation of Cameroon's currency. Cameroon's economic development was threatened (MINAGRI, 1990). A major limitation of this policy was that the emphasis on increasing production of non-food and food exports to increase foreign exchange earnings led to the neglect of local food consumption and food security.

The decreases in the value of its export crops since 1985 made the Government realise that, although food self-sufficiency has been achieved in Cameroon, food crop production and marketing potentials were still under-exploited because the domestic food crop sector had been virtually neglected. In order to meet this challenge, the Government adopted a new policy where the main goal was "To seek the consolidation of the achievement of food self-sufficiency and export earnings and a considerable improvement of Cameroon's agricultural production" (Ibid.: 14). The strategy adopted was to diversify and modernise domestic food crop production and improve marketing potential. The modernisation of production systems, which was considered a *sine qua non* of the new agricultural policy (Ibid.), was focused on i) plant breeding and intensifying agronomic research, ii) soil conservation and rehabilitation, iii) agricultural mechanisation, iv) guiding farmers in their production activities through extension, and helping them to organise themselves into groups and associations to become more efficient and eventually to develop such groups into farmer cooperatives.

Food security was to be maintained through a special emphasis on production, preservation (processing, storage and packaging), and distribution of domestic food crops, curbing acute malnutrition, and reinforcing the effective demand of poverty-stricken social and economic groups. The major activity in the food crop sector was the promotion of specific crops according to major agroecological zones in order to utilise existing potentials and boost regional specialisation. Two of the means by which this was to be achieved were: 1) the intensification of formal plant breeding and improving farming techniques (especially for drought resistance and multi-cropping) on the part of government research institutions, and 2) dissemination of available research findings and improved crop varieties to farmers through the extension services of the Ministry of Agriculture.

Since 1985, the Government's concentrated efforts to develop the food crop sector led to the elaboration of the First Cameroon Rural Development Strategy in 2002, which continued to emphasise the modernisation of agricultural production systems (intensification and development of sub-sectors of crops with high economic potential) and the adoption of a framework that encourages private sector initiatives, thus purportedly favouring equity within a market economy. Crops with economic potentials included maize, cassava, cocoyam, colocasia (taro), sweet potato, plantain, and Irish potato. The main goal was to encourage profitability and promote the emergence of a market for factors of production and thus a dynamic rural economy that would grow at a rate at least three percentage points higher than Cameroon's overall economic growth rate. In this, the availability of inputs, the viability of production systems, the availability of technology, the promotion of added value and the improvement of processing, competitiveness, and support to producer organisations, were some of the 19 areas of intervention envisaged.

Two programmes were created to support and backstop farmers:

- The National Agricultural Extension and Training Programme (NAETP or PNVFA, its French Acronym) which was created in 1985 and, later on, evolved into the National Agricultural Extension and Research Programme in 1992 to assist small-scale farmers of all food crops and livestock in the national territory;
- The National Market-Driven Root and Tuber Programme (NMDRTP) (the Programme National de Developpement des Racines et Tubercules - PNDRT in French) was created in 2005 to specifically develop the root and tuber crop sector across the entire territory. It is an International Fund for Agricultural Development (IFAD) funded programme.

The emphasis of Cameroon's food crop sector development policy is on increased production for the market. Following this market-driven orientation, from 1986 onwards, improved high yielding cassava and other crop varieties have and are being developed by research institutions and released to farmers through extension services. For example, PNDRT's objective is to improve: i) the productivity of roots and tubers crops through intensification and diversification of research and technology within small farming systems; ii) multiplication of improved foundation plant material by networks of farmer-multipliers; iii) integrated pest management; and v) sustainable soil management. PNDRT is involved in the multiplication and distribution of improved cassava plant material where the estimated requirement in 2006 was 65 million cuttings/year (Mbairanodji, 2007). PNDRT works in partnership with regional research institutions, the International Institute of Tropical Agriculture (IITA), and the Institute of Agronomic Research and Development (IARD or IRAD, its French Acronym). As of 2007, 70 farmer field schools had been established to train farmers in integrated crop protection techniques and plant material multiplication. Plant material multiplication fields were also established on 201 ha of land. In total, some 470,000 cuttings were harvested and distributed to farmers' organisations and research institutions (IRAD and IITA). In the area of cassava processing, PNDRT activities are directed toward promoting the production of unfermented cassava flour for use in agri-food industries (bakeries), testing processing equipment, and studying priority problems encountered in processing (Ibid.).

While the Ministry of Agriculture and Rural Development promotes the multiplication, distribution, and production of improved cassava varieties among farmers, the development and release of improved cassava varieties was and is the responsibility of the Ministry of Scientific Research and Innovation. The main regional research institutions that have been actively involved in the development of cassava and other root and tuber crops are IITA and IRAD, which work in close collaboration.

According to Fonseca (2005),[2] research activities on the improvement of root crop production in Cameroon started in the late 1970s, where the Root Crops Cameroon Project was created as a collaboration between the Canadian Government (through the International Development Research Centre-IDRC), IITA, and the Cameroon Government (through the Office National de la Recherche Scientifique et Technique-ONAREST of the Institute of Agronomic Research (IRA)). In Phase I of this project a survey was carried out and a collection of local varieties was crossbred with material selected from IITA to combine disease resistance and high yield with the adaptability and acceptability of locally established varieties. Phase II of this project continued to increase root crop production and identify desirable genetic attributes to generate elite varieties. More specifically, cassava seedling evaluation continued for high yields, vigour, and disease and insect resistance. Improved agronomic techniques were developed for farmers in various agroecological zones. Researchers also developed a method to enrich cassava flour with 10% soya flour to increase protein content, and a cassava pulp dryer was constructed. Training Cameroon scientists developed a strong indigenous, institutional base for research. Phase III continued to develop improved cassava varieties while incorporating field resistance to major diseases and pests into the improved varieties as well as developing improved cropping practices that were meant to be readily accepted by farmers. Phases I and II led to the creation of the Cameroon National Root Crops Improvement Programme (CNRCIP) in 1981/82 (IITA, 1988/1989). CNRCIP's mandate was to develop production systems suitable and acceptable to small farmers to increase the yields of major root crops (cassava, yam, cocoyam, sweet potato, and solanum potato) in Cameroon.

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[2]Fonsesca, A. 2005. Root Crops (Cameroon) Phase II. IDRC Bulletin. International Development Research Centre.

The five major goals of cassava improvement programmes and therefore of CNRCIP and IITA are:

- Identify and utilise genetic sources of resistance to cassava's major economic pests and diseases;
- Incorporate disease and insect resistance into cassava varieties having high yield potentials, high nutritive quality, and consumer acceptance, and that are adapted to different agro-ecological zones;
- Develop cultural practices that are suitable for use by low resource farmers to maximise the yields of improved or local cassava varieties with minimum inputs;
- Develop rapid multiplication techniques for improved plant material for use by small farmers;
- Elaborate appropriate processing and storage technologies to reduce post-harvest losses and study the market for cassava and its derived products.

The ultimate goal has been an increased production and marketing of cassava in Cameroon (IRAD, 1982, 1983, 1985, 1989; CNRCIP, 1982, 1983, 1985; IITA, 2007).

Some agencies that have funded cassava improvement in Cameroon are the Cameroon Government, the Canadian Government, IITA, the Belgian Government (The General Administration for Cooperation in Development-AGCD), USAID, the International Fund for Agricultural Development (IFAD), the World Bank, and the African Development Bank (AfDB).

In an interview with Dr. Meppe Packo (Sub-director in charge of Valorisation and Innovation for Annual Crops at IRAD Nkolbisson Yaounde, Pers. Comm., 2009) indicated that the Cameroon Government has never had a good breeding support programme for its research institution - IRAD, and thus the agency was more involved in adaptive research and multiplication of planting materials for distribution. As a result, the improved cassava varieties that were released to farmers in 1986 came from IITA germplasm. Between 1986 and 1990, nine improved varieties (clones) were released to farmers after testing for adaptability and acceptance, including: 8034, 8061, 8017, 1005, 1171, 1141, 224, 466 and 4117. These varieties were distributed according to their adaptability to the different agroecological zones. Since 1986, when the first cassava varieties were released, about 25 varieties have been released to Cameroon to date although farmers have not accepted most of them. IITA has released 11 varieties have been released to farmers through the Market-Driven National Root and Tuber Development Programme (PNDRT), including 92/0326, 96/1414, 880713, 8804772, 96/0023, 8085, B-BulkP6, 92/0057, 95/109, 96/1762 and LMR (IITA 2007, E. Njukwe - IITA Cameroon Research Associate, Pers. Comm.2009).

All of the HYV varieties that have been released to Cameroon to date are early maturing varieties, which often do not meet farmers' priorities compared to the late maturing varieties. Genetically, early maturing varieties are low yielding compared with late maturing varieties; however, when targeting the market, greater benefit (turnover) can be derived with early maturing varieties (Dr. M. Packo, Sub-director in charge of Valorisation and Innovation for Annual Crops at IRAD Nkolbisson Yaounde, Pers. Comm., 2009). Since the research orientation in cassava is targeted at the market, early maturing varieties are therefore given greater priority in IITA's breeding strategies. Since 1998, IRAD's strategic goal has been to adopt a scaling up and scaling out approach, where not only yield and environment are determining factors, but marketing and processing qualities as well. In their strategic vision, working in partnership with farmers, business institutions, food processors, NGOs, and civil society will help to develop varieties that are acceptable and have a high market demand and value at the time of their release (Ibid.).

2.3.2 AGRA Goals, Assumptions and Modalities of Implementation and their Relation to Cassava

The Alliance for a New Green Revolution in Africa (AGRA) is a partnership agreement between the Rockefeller Foundation and the Bill and Melinda Gates Foundation, which was created in 2006 in response to the need to help millions of small-scale African farmers to rapidly and sustainably increase their productivity and lift themselves out of poverty. This partnership is intended to improve agricultural development in Africa by addressing issues related to soil fertility and irrigation, farmer management practices, improving planting material quality and productivity, and farmer access to markets and financing. The aim is to significantly reduce hunger through an increase in the productivity of small farms, thus moving millions out of extreme poverty.[3] This joint effort builds on the work of the Rockefeller Foundation, which launched the Green Revolution between the 1940s and 1960s, where the development and dissemination of improved crop varieties and farm management practices was the main approach that pioneered the historic transformation of farming methods in Latin America and South and Southeast Asia. While it is believed that success for Africa is far from assured due to the complex challenges that have been faced by the earliest pioneers and that are still present today, it is argued that the basic elements of the first Green Revolution still apply, at least in broad stokes, to the needs of African farmers today. AGRA is therefore intended to build on the successes of the original Green Revolution, which included the development of more productive crops and fertilisers; the cultivation of local talent (education in to plant science, farming, and business development); the commitment of national governments; public-private collaboration (on water and irrigation, infrastructure, environment); and on building markets for inputs while addressing the weaknesses identified above.

AGRA constitutes part of the Rockefeller Foundations' Strengthening Food Security Initiative, which is supported across four interrelated areas of activities: i) improving access to more resilient seeds that produce higher and more stable yields, ii) promoting soil health and productivity, iii) building more efficient local, national and regional agricultural markets, and iv) promoting improved policies and building partnerships to develop the technological and institutional changes needed to achieve a Green Revolution[4]

2.3.2.1 AGRA assumptions, seeds, and soils

The rationale behind the creation of AGRA is that African farmers expand their agricultural production to feed their growing families in an often inefficient and unsustainable way. This inefficiency is supposedly due to the fact that crops on the great majority of small

[3]http://www.rockefellerfoundation.org/news/publications/africas-turn-new-green-revolution. Accessed 17/11/2008.

[4]http://www.rockefellerfoundation.org/what-we-do/current-work/strengthening-food-security-alliance. Accessed 25-6-2010

farms are not the high-yielding varieties that are in common use on other continents. It is also argued that African farmers literally mine their naturally poor soils, with little or no replenishment through fertiliser use. It is believed that inefficiency and risk of food shortages could be reduced or eliminated if better seeds and the related effective technologies could reach African farmers. As such, farms could in time be converted from subsistence to surplus production, with the additional harvest available for sale locally or regionally (source: see footnote 2).

While it is argued that the former Green Revolution succeeded in Asia, Latin America, and Mexico, it failed in Africa. The following reasons for this failure were identified:

- Breeding for uniformity rather than diversity, which made the process of bringing higher-yielding seeds to Africa's small farms more challenging and complicated due to Africa's diverse climate, soil, and range of suitable crops as compared to Asia or Latin America;
- Irrigation was far more widespread in Asia than in Africa;
- Fewer teams of trained scientists were available to work in large breeding programmes;
- The knowledge of African farmers' was barely included in researchers' breeding, testing and selection strategies;
- Breeding programmes were concentrated in few locations and not decentralised and so could not reflect the needs of farmers producing in specific agroecological niches;
- The initiative required an immediate and sweeping agricultural transformation from subsistence to surplus production;
- The wide spread use of better fertilisers by small-scale African farmers was limited due to high prices that result from poor road infrastructure and high transport costs, as well as government trade tariffs and tax policies;
- Rudimentary agricultural extension systems which are the mainstay of farmer education and technology transfer in Africa could not train farmers on the use of fertilisers and agricultural inputs and facilitate input distribution;
- Farming systems were not subsidised;
- The existence of rudimentary market systems, infrastructure, and the technology, which are essential if transactions are to be efficient.

These problems should be addressed by:

- Developing higher-yielding crop varieties suitable to Africa's various regions and niche environments;
- Encouraging the participation of farmers in each region in the breeding, testing, and selection process;
- Training generations of African scientists and crop breeders;
- Encouraging the use of improved fertilisers to obtain greater yields given the right combination of seeds, soils and added nutrients;
- Establishing an African fertiliser financing mechanism within the African Development Bank;

- Developing and strengthen (through subsidies) the agro-dealers industry (village retailers who sell seeds, fertilizer, and farm tools) to build market mechanisms for helping farmers buy better inputs and learn how to use them. Training village merchants in the basics of retailing farm supplies - including how to help farmers understand and use the products - and helping them finance their businesses with loan guarantees and other credit support will cultivate a new market sector that strengthens both small retailers and small farmers;
- Supporting the development of markets, cooperatives, and small enterprises in rural Africa to facilitate the processing, transportation, and marketing of farmers' produce and fund microfinance and agricultural lending programs to make a successful transformation of Africa's agriculture;
- Funding the development of infrastructure to facilitate storage, processing, transportation and marketing of farmers' produce;
- Governments should elaborate business-friendly policies to encourage the formation of processing, transport, and equipment enterprises and trade, among many other market essentials.

AGRA thus aims to ensure that smallholders have what AGRA argues they need to succeed: good seeds and healthy soils; access to markets, information, financing, storage, and transport; and policies that provide them with comprehensive support. AGRA's aim is to boost farm productivity across more challenging environments, especially Africa's high-potential breadbaskets. Its activity is oriented toward transforming smallholder agriculture into a highly productive, efficient, sustainable and competitive system while protecting the environment. AGRA's key areas of intervention and activities include[5]:

- Developing better and more appropriate seeds;
- Fortifying depleted soils with responsible use of soil nutrients and better management practices;
- Improving access to water and water-use efficiency;
- Improving income opportunities through better agricultural input and output markets;
- Developing local networks of agricultural education;
- Understanding and sharing the wealth of African farmer knowledge;
- Encouraging government policies that support small-scale farmers;
- Monitoring and evaluation to ensure that AGRA efforts improve the lives of small-scale farmers.

AGRA also intends to promote opportunities that strengthen mixed crop-livestock systems throughout all of its areas of intervention because of the crucial role that livestock plays for small-scale farmers.

The development of improved seeds and use of chemical fertilisers and soil management practices are the two areas of concern in this dissertation. AGRA's main arguments in support of these two areas of intervention are:

[5] http://www.agra.org/work. Accessed 18/11/2008.

> Africa has the singular and tragic distinction of being the only place in the world where overall food security and livelihoods are deteriorating. Over the last 15 years, the number of Africans living below the poverty line ($1/day) has increased by 50 percent, and it is estimated that one-third of the continent's population suffers from hunger. In the past five years alone, the number of underweight children in Africa has risen by about 12 percent. A root cause of this entrenched and deepening poverty is the fact that millions of small-scale farmers—the majority of them women working farms smaller than one hectare—cannot grow enough food to sustain their families, their communities, or their countries…. Per capita food production has declined in Africa for the past 30 years and farm productivity in Africa is just one-quarter the global average…. Few farmers in sub-Saharan Africa have access to new improved varieties of local food crops capable of producing abundant harvests in what are often harsh conditions…
>
> Low soil fertility is one of the major factors responsible for depressed yields on small-scale farms across Africa and for Africa's low agricultural productivity relative to other regions. Cereal yields in Sub-Saharan Africa averaged less than 1.3 tons per hectare in 2000, as compared to yields in East and Southeast Asia, and South Asia, of 3.4 and 2.9 tons per hectare, respectively. While other developing regions have seen cereal yields grow annually during 1980-2000 from 1.2 to 2.3 percent, cereal yields in Africa grew at an average rate of 0.7 percent, according to the World Bank. Africa's food production lags because its soils are low in nutrients, low in organic matter and have poor water holding capacity. Until those conditions are reversed, Africa's soils will continue to degrade and its food situation will continue to deteriorate…. In the current global food crisis, the continuing rising costs of fertilizer and fuel raises concerns for agriculture experts. Increasing prices, exacerbated by floods and droughts, continue to pose additional challenges for farmers throughout Africa.[6]

In accordance with these arguments, AGRA proposes to develop crop varieties (using farmer-participatory methods) that are disease and pest-resistant, grow well in local environments, able to withstand climatic variations, and meet consumer preferences.

In June 2006, the Africa Fertilizer Summit was held in Abuja, Nigeria, where over 40 African governments agreed to increase the use of fertilisers from 5kg/ha to 59kg/ha as well as lift all cross-border taxes and tariffs on fertiliser in response to the need to provide rural African farmers with affordable soil nutrients. Building on the recommendations of this summit, the Integrated Soil Health Initiative was created as one of AGRA's initiatives[7]. AGRA's Soil Health Initiative will promote locally appropriate soil management practices that combine the use of organic matter and fertilisers to restore soil health, in an approach known as Integrated Soil Fertility Management.

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6 http://www.gatesfoundation.org/learning/Pages/progress-report-agra-soil-health-program-farms-africa.aspx. Accessed 20/05/2010.

7 http://www.agra-alliance.org/section/work/soils. Accessed 20/05/2010.

2.3.2.2 Major achievements in seed development and soil restoration

AGRA purposely targets the development and release of 1000 improved varieties of the following crops: maize, cassava, beans, rice, sorghum, and other crops resistant to diseases and pests within 10 years. As of 2009, its initiatives had worked to strengthen the seed sector through i) the provision of grants to 24 small-scale and medium sized companies and cooperatives to multiple improved groundnut and cassava; ii) funding of participatory crop breeding that has resulted in the release of 68 improved cassava, maize, bean, and sorghum varieties; iii) bolstering a network of breeders of cassava, maize, bean and rice; iv) developing a fertilizer value chain and fertilizer manufacture to increase access for smallholder farmers in Tanzania; v) launching a Soil Health Programme with the goal of regenerating 6.3 million hectares of degraded farmland over 10 years through balanced integrated soil fertility management; vi) launching an African Soil Information System; vii) providing grants for 13 input supply and fertilizer manufacturing projects in nine countries: Ghana, Kenya, Mali, Malawi, Mozambique, Nigeria, Tanzania, Uganda and Zambia.

2.3.3 Goals, Assumptions, and Modalities of Implementation of CGIAR Institutions in Relation to Cassava

According to Jennings and Iglesias (2002), cassava was adapted to African and Asian conditions during the post-Columbian period after its evolution as a food crop some 2000 to 3000 years BC. Farmers' selection for adaptation and quality led to the generation of a wide range of genetic diversity (Bonierbale et al., 1995; Jennings and Iglesias, 2002). Serious attempts on the part of national organizations to improve the plant's breeding started in the 20th century at the instigation of colonial powers, but slowed down with the independence of nations. In the 1960s, the increase in the world's population and limited supplies of energy food prompted an interest in the crop, and high priority was given to breeding and related research. This led to the creation of IITA in Nigeria and CIAT (the Centro de Agricultura Tropical - the Centre for Tropical Agriculture) in Colombia. CTCRI India later on took on the same role. The aim was to extend the Green Revolution's success to less privileged tropical populations (Kawano, 2003). The goal was to establish a cassava breeding programme with a global perspective that would generate economic benefits targeted at the rural poor.

CIAT and IITA's mandates were to improve yields per unit area as well as the area under cultivation and root quality. As a result, new varieties (cultivars) were developed. The initial decade was mainly dedicated to the collection of germplasm and the generation of basic breeding materials. Later decades were devoted to applied breeding in collaboration with international and national programs in Latin America, Asia, and Africa (IITA, 1988/89; Manyong et al., 2000; IITA, 2000; Jennings and Iglesias, 2002; Kawana, 2003) The aim was that improvement of crosses from IITA and CIAT would first be incorporated into broad based breeding populations before being subjected to further selection by local research institutes. The improved germplasm obtained from the introgression of exotic germplasm that had improved populations of desirable gene complexes were distributed either through *in vitro* transfer of elite genotypes, or as populations of recombinant seeds (full sibs or half sibs) (Bonierbale et al., 1995). The narrow base germplasm of the original importations were crossed naturally with heterozygous varieties and selections of self-sown seedlings to facilitate local adaptation. Natural crosses with *Manihot glaziovii* (ceara rubber) produced the tree cassava, which may have broadened the genetic base of cassava in Africa (Jennings and Iglesias, 2002). The following operating principles or processes were closely adhered to: (i) establishment of breeding methodology; (ii) generation of useful breeding materials; (iii) distribution of advanced breeding materials to national programs; (iv) establishment of competent national cassava breeding programmes; (v) development of improved cultivars; and (vi) dissemination of cultivars.

In the 1980s, cassava was accorded the highest priority in IITA's Root, Tuber and Plantain Improvement Programme (IITA, 1988/89) because of its importance as a food security crop and its ability to produce more food utilising less labour compared to other food crops. Due to its susceptibility to diseases, insect pests, nematodes, and weeds that are major constraints to increased production, the crop improvement programme had the following aim: to develop and disseminate improved high yielding varieties (HYV) that combine high yields, resistance to major diseases and pests, and adaptation to a wide range of ecological conditions and farming systems. The varieties were also meant to taste good and have other qualities that make them suitable for making popular dishes so as to be appealing to consumers. The major successes recorded were the breeding of high yielding varieties that have reduced cyanide content and resistance to the two most destructive cassava pathogens in Africa: Cassava Mosïac Virus (CMV) and the Cassava Bacterial Blight. Rapid plant material multiplication techniques were also developed.

In 1981-82, biological control of the cassava mealy bug was promoted in Nigeria by releasing a natural parasite called Epidimocarsis lopezi (a tiny wasp) which was later released by air and on the ground in 18 countries across Africa's cassava belt. This later led to the development of varieties that are resistant to the cassava mealybug and green mite pests as well as varieties that are suitable for major African intercropping systems. Breeders also succeeded in identifying the genes that cause varietal differences in drought tolerance and the microorganism that causes root rot in cassava roots and tubers. Other pests and disease that have received attention include variegated grasshopper and cassava anthracnose disease (CAD) (IITA, 2007). Based on the objective of developing cassava varieties that are appealing to African farmers in terms of taste and other qualities that are suitable for making popular African dishes, the yellow root flesh varieties were developed in 1988 (IITA, 1988/89). These yellow varieties have high carotene content, which are suitable for making yellow gari and do not require the use of palm oil during toasting. As discussed above, gari, which is also called aka tapioca, is one of the main processed cassava product that is consumed locally and regionally in Africa. The growing African demand for bread led to the discovery of the quality of cassava flour as a partial substitute for imported wheat flour.

By 1989, IITA had distributed improved HYVs and locally named varieties selected from their breeding materials to different African countries: Cameroon, Gabon, Liberia, Nigeria, Rwanda, Seychelles, Sierra Leone, Tanzania and Zaire. Since 1979, IITA Ibadan, Nigeria has been forwarding a bulk of seed material to IRAD Cameroon and, currently, to IITA Nkolbison, Cameroon, for on-station and on-farm trials of its adaptability in Cameroon and onward release to farmers. Another institution that has been involved in cassava improvement is the International Fund for Agricultural Development (IFAD), which led a collaborative effort aimed at developing a global strategy to promote cassava as an important staple food and income source for farmers. One goal is to spur rural industrial development that will increase employment opportunities and raise incomes of producers, processors, and traders. The strategy aims to promote products with good market potential, including: cassava flour as an ingredient for home cooking and industrial use, fufu, cooked leaves and boiled roots, animal feed, alcohol for chemical industries, glue, starches for sizing textiles and paper, and industrial sweeteners. The strategy also seeks to broaden the recognition of cassava's important role in food security. At a forum in April 2000 hosted by FAO and IFAD, participants from 20 countries representing private enterprises, farmers' groups, NGOs, researchers, and donor agencies endorsed that strategy. Various research and market promotion activities were devised, and plans for their implementation were outlined (FAO, 2000).

2.3.4 Comparison between Policies, Goals, and Research Orientations

This section compares and contrasts the Cameron Government's policies, goals, and research orientations and the goals and assumptions of AGRA and the CGIAR institutions, and examines the factors that have influenced the development of each. It argues that, while cassava has been promoted as a means to ensure food security and generate income for small farmers, all of these stakeholders have given most attention to its economic importance. For example, the Cameroon Government's interest in cassava resulted from the decrease in its national export earnings and the country's inability to pay its international debt as a consequence of the decline in the world market prices of its traditional export crops. As such, its major policy orientation has been toward modernising cassava production systems through intensification and development of the sub sector because of its high economic potential. Cassava's role in ensuring food security has been viewed only in terms of boosting regional specialisation since it is a staple crop for some regions. The CGIAR system views cassava as a crop that can help to satisfy the food energy needs of an increasing world population and generate economic benefits for the less privileged in rural areas. AGRA has viewed cassava in terms of reducing food shortages in Africa, which could eventually lead to surplus production that can be sold locally or regionally. Clearly the policies are market-oriented policies and all of the different strategies adopted by the Cameroon Government, the CGIAR institutions (IITA, CIAT) and AGRA are to increase productivity and production through the use of external inputs in order to meet market demands for specific cassava products, including a strong increase in industrial processing and use. The traditional foodways, crop diversity, nutritional diversity and security, and cultural, spiritual, and economic significance of cassava have not been emphasised in cassava breeding programmes, which have favoured the productivity and environmental variables (adaptability, pest and disease resistance, plant material multiplication, yield, early maturation, and high starch content) of the different cassava varieties bred. The only nutritional quality improvements that have been targeted were directed at gari and flour, which are the major cassava commodities and thus potential the subject of mass production and homogenization in Africa.

2.4 Assumptions and Lacunae in Cassava Policies and Practices

This section outlines the main arguments put forth in this dissertation about the assumptions and lacunae in cassava policies and practices that may deter rather than promote cassava production systems that can meet small farm households' needs for food security, cultural and social integrity, income, and agroecological sustainability.

2.4.1 Cassava Breeding

The main assumption behind the selection, breeding, and dissemination of improved cassava varieties is that farmers' local varieties are not high yielding and are highly susceptible to pests and diseases compared with the improved varieties. It is argued in this dissertation that, if African smallholders' objective is mainly to increase productivity (yield per unit area) and, if local varieties are actually low yielding, and then HYVs should out-compete local varieties. HYVs would therefore have a higher level of salience (meaningfulness) among farmers due to the comparative advantages that they have over local varieties. Nevertheless, as will be shown, in the most important cassava belt in Cameroon, where cassava HYVs have been promoted for several decades, men and women farmers mainly produce local varieties for own consumption as well as for sale, and cassava HYVs have relatively low salience for them.

Although AGRA's objective is to correct some of the errors of the past Green Revolution by forming a partnership with small-scale farmers and especially women in order to draw upon their local knowledge in breeding programmes, national and regional research institutions responsible for the development of cassava HYVs may not be able to improve upon their breeding strategies since no concrete methodology for achieving this has been specified. If breeders modify their strategies to increase farmer participation, their partners may be limited to specific categories, and thus the varieties bred may not meet the needs, interests, and priorities of the majority of farmers. An investigation of how farmers actively participate in researchers' cassava breeding programmes is beyond the scope of this research. However, the analysis of the data collected has focused on the acceptability of the research HYVs that were released between 1986 and 2002 across farmer socioeconomic groups and in two different villages: one that is less commercially oriented, ethnically homogeneous, and more traditional, and another that is more commercially oriented, ethnically diverse, and less traditional. The cognitive ethnobiology methodological protocol used for data collection and analysis in this research (see chapters 3 and 5) represents a potentially useful means to systematically target and document farmers' varietal knowledge and preferences and to relate these to farmer behaviour when new crop varieties are developed. It is proposed that this more comprehensive methodology may be useful for understanding farmers' knowledge and perceptions, which influence their decision-making frameworks in crop improvement strategies.

The productivity of crop varieties is the main focus of policies and programmes of the Cameroon Government, AGRA and international research institutions, which tend to neglect the multiple reasons for which farmers chose which varieties to grow. It is argued here and elsewhere in this dissertation that food crops are not only produced to meet farmers' nutritional or biological needs, but also to fulfil socio-cultural, economic and agroecological needs and as well to manage their land and labour constraints. Furthermore, it is argued that, unless farmers are principally oriented toward producing for extra-local markets (e.g. exports, industries), it is their own food choices and preferences and those of other local populations that determine which crops to grow and sell in local markets. Farmers' strategies for ensuring household food and nutrition security are determined by their local foodways, which in turn influence farming systems and crop diversity. Wide acceptance of HYV may lead to household nutritional insecurity as a result of the simplification of traditional farming systems and thus of diets. Crop diversity, dietary diversity and nutrition diversity and security are interrelated and therefore changes in one aspect affect the others.

2.4.2 The Agroecology of Cassava Production

In promoting a ‘new green revolution’ for Africa, AGRA, the Cameroon Government, and other research institutions such as CIAT, IITA, and IRAD generally assume that traditional agroecological systems (farming systems) and practices are neither highly productive nor sustainable. Essentially, the argument is that traditional farming systems are unsustainable because soils are mined, little or no chemical fertiliser is used, and fallow periods that in the past provided for nutrient recycling, are declining as a consequence of population growth, leading to a decline in *per capita* crop yields.

Two major arguments put forth in this thesis are:

- Most often, the productivity of cereal crops are used to draw conclusions about the productivity of traditional African farming systems and the food security status of households, whereas cereals are not staple crops for many African communities and therefore their production is bound to be low compared to roots and tubers crops and plantain/banana.
- The traditional agroecological systems under study are more adaptive, resilient, and sustainable and higher yielding, compared to high input monoculture systems that depend on external inputs, which are generally promoted by research institutions, AGRA, and the Cameroon Government.

2.4.3 Cassava Marketing and Consumption

In the promotion of a ‘new green revolution’ for Africa, AGRA, the Cameroon Government, and other research institutions assume that per capita food production in Africa is declining, leading to millions of families living in poverty and hunger. A fundamental solution has been to promote improved high yielding crop varieties, including cassava. In this dissertation it is argued that, in the study area, which is representative of the ‘high end’ of cassava production in Cameroon, cassava farmers’ objectives are to ensure food security and a livelihood. Further, their food production systems actually achieve these objectives, whereas the high yielding cassava varieties (HYVs) contribute relatively little.

2.5 The Study Sites

This section discusses the suitability of the study area for the research topic by looking at the similarities and differences in the agroecology, livelihoods, production orientation, access to cassava markets and to research and extension, and the degree of adherence to cultural traditions. The similarities and differences that are discussed here below and summarised in Table 3.1 of Chapter 3 were used as the guiding principle for the selection of the study sites, and these will form the basis of the interpretation of the arguments set forth in this research and the conclusions to be made.

2.5.1 Rational in the Choice of the Two Study Sites

The purpose of this research is to have a clear understanding of the implications of the promotion of high yielding cassava varieties and the use of agricultural inputs, particularly chemical fertilisers, by the Cameroon Government, AGRA, and research institutions, for the sustainability and resilience of traditional farming systems, food security, rural livelihoods and income, so as to make policy recommendations, contribute to international and national debates, and provide a reference document for research. It was therefore necessary to select research sites that permit testing of the hypotheses, examination of the assumptions, and identification of the lacunae as put forth in Section 2.4. Such research should be comparative, to represent both 'traditional' cassava production systems that are more oriented toward own consumption, and 'modern' systems that are more market oriented. Both sites should be located in areas where the commercial potential for cassava sales are high, permitting this variable to be 'controlled' (e.g. market access does not present a constraint). The smallholder communities should also be more 'traditional' and 'modern' in a cultural sense. 'Traditional' can be represented by long-term settlement, ethnic homogeneity, and adherence to traditional beliefs and rituals. 'Modern' can be represented by shorter-term settlement and ethnic heterogeneity. Both communities should be located in Cameroon's major cassava producing belt and have been the target of government extension and research efforts to promote modernisation of cassava production (dissemination of cassava HYVs with extension advice, at a minimum). Preferably, the two communities would be located in different agroecological zones and display differences in farming systems. Based on these major criteria, the villages of Malende and Koudandeng were selected for in-depth, comparative research.

2.5.1.1 Access to cassava markets

As discussed in Section 2.2.3 above, cassava is a major commercial and subsistence crop that is produced and sold on a significant scale in Koudandeng and Malende. The two villages are located in semi-urban areas and urban peripheries, where commercial cassava production is greatly influenced by the urban and semi-urban markets of Yaounde, Obala, and Nkometou (in the case of Koudandeng) and Buea, Tiko, Limbe, Douala, and Muyuka (in the case of Malende). Koudandeng is located 30 km from Yaounde and transport is available through unofficially registered taxis called 'opep' and motorbikes at a cost that farmers generally can afford. Malende is located 10 km from Muyuka and transport is available through registered taxis and opep, motorbikes and buses at a cost that farmers can afford. Thus, both villages have good access to markets for cassava and cassava products. While Koudandeng is an important supplier of baton and fresh roots to the Yaounde urban markets, Malende is an important supplier of gari to the Muyuka market.

2.5.1.2 Orientation of cassava production

Malende and Koudandeng are characterised by high population pressure and good market access, and agricultural production has become diversified and commercialised over time in both villages, although to a lesser extent in Koudandeng compared with Malende. Malende markets around 80% of the total cassava produced, whereas Koudandeng markets around 35%. Koudandeng sells more fresh cassava roots, baton (a fermented cassava product wrapped in leaves of a wild plant which is boiled before eating) and, to a lesser extent, cous-cous (a dried fermented cassava product that is milled into flour before preparing as a meal). Malende, on the other hand, markets more gari (aka tapioca), which is non-perishable and has a higher relative market value compared with fresh cassava roots and baton. It also markets water fufu, which is a fermented cassava paste that is prepared into a meal. Unlike Koudandeng, where cassava is a staple crop and only 35.5% of total cassava produce is sold, cassava is a cash crop in Malende, where about 80% of total production is sold. This means that there are especially potential trade-offs between marketing and own consumption in Koudandeng with wide scale acceptance of HYVs.

2.5.1.3 Access to cassava HYVs and research and extension

Koudandeng is a village of the Obala Sub-division of Lekie Division in the Centre Province, whereas Malende is found in the Muyuka Sub-division of Fako Division of the Southwest Province. Muyuka and Obala are strong cassava producing areas and have thus been the targets of interventions on the part of research and extension institutions more than other regions of Cameroon. Obala also falls within the IITA's Forest Margin Bench Mark research areas of the Congo Basin. As discussed in section 2.3.3 above, IITA is one of the CGIAR institutions has played a major role in breeding and release of improved cassava varieties and technological packages in the African region as a whole and in Cameroon in particular. Although the Muyuka and Obala sub-divisions have both been targeted more than other sub-divisions in Cameroon by Government research and extension activities, Koudandeng has received less attention relative to Malende.

The Ministry of Agriculture and Rural Development (MINADER) is responsible for providing extension services to farmers in the entire country and works through its local structures. For example, the sub-divisional delegations of MINADER assist farmers in rural areas. At the same time, the National Agricultural Extension and Research Programme (NAERP) and the National Market-Driven Root and Tuber Development Programme (NMDRTDP or PNDRT, its French acronym) that are MINADER projects, also assist farmers in the entire country (see section 2.3 above). NAERP's provincial, divisional, and sub-divisional structures are located within the delegates of MINADER and work under the control of the heads of delegations at different levels, and therefore assist farmers throughout the country. The staff that work with farmers in the villages are called Zonal Extension Workers (ZEW) who most often hold cumulative functions as Chief of Post for Agriculture and Rural Development.

a) Koudandeng

Results of the reconnaissance survey that was carried out in 2002 in Koudandeng indicated that three institutions had in the past or were currently intervening in relation to cassava in Koudandeng: the Ministry of Agriculture and Rural Development (MINADER), COSADAIRE, and the World Food Programme (WFP). COSADAIRE, which is a union of NGOs based in Yaounde, is the main NGO that has assisted one Common Initiative Group (CIG) called Oyili Mbenbengnyane Rural Development Group that has over 50 members in Koudandeng by i) linking up this group to the World WFP for the purchase of cassava flour in 1997 (this market ended in 2001 as a result of conflicts due to the mismanagement of group funds); ii) training female members in cassava processing techniques (gari, couscous and dried cassava chips); and iii) providing a small scale motorised cassava processor (grater) and corn mill to this group.

MINADER did not intervene in relation to cassava in Koudandeng until 2000, when cassava was identified as one of the potential food crops for development into a sub-sector. As discussed in section 2.3 above, the government's major policy orientation has been toward modernising cassava production systems through intensification and development of the sub-sector because of its high economic potential. The ZEW/Chief of Post for Agriculture and Rural development worked only with the Oyili Mbenbengnyane Rural Development Common Initiative Group (CIG) which is well structured and organised (has a bureau, is officially registered, and has specialised sub-groups working on different crops: cocoa, cassava, and maize). Female members of this producer organisation constitute the sub-group working on cassava and they have received training in cultivation techniques to improve their yields, but they are reticent to adopt the planting method that is promoted, where cassava cuttings are slanted at an angle of 45° to the ground. It is a general belief that this method is time consuming and more tedious than the method the women use, where cassava cuttings are planted on flats with all of the cuttings covered underground.

A discussion with some female farmers about why they do not work with the ZEW/Chief of Agricultural Post MINADER indicated that they are generally ignorant of ZEW's functions. "I did not know that the Chief of Agriculture post is here for everybody. I thought he was for others. Now that you have explained the importance of working with him, I will try to contact him," explained a female respondent in Koudandeng. The Delegate of the Oyili Development Group in Koudandeng said, "I used to see the Chief of Post pass by on his motor bike. I saw him work with others, but one day I stopped him and asked what he was actually doing and whether he will be willing to work with my group. He showed the interest and immediately sought to meet members of our group. This is how we started working with him. You only need to contact him and show your interest." Another, however, retorted: "You people in this village only want to hear or believe what is said by a stranger rather than by a member of your community." At the time of this research, five farmer groups existed, two that work with the ZEW/Chief of Agricultural Post for this Edingding zone to which Koudandeng belongs. Frequent transfers and lack of means of transport to facilitate movement by staff led to the discontinuation of the services of MINADER (Chief of Post/ZEW) between 2004 and 2007. However, a new staff member was appointed to cover Koudandeng and its neighbouring villages in 2008.

MINADER has not actually influenced the cassava varieties planted in this locality because the ZEW/Chief of Posts themselves do not have access to the HYV varieties that were introduced by research institutions. A discussion with six male and female farmers indicated that the HYV variety called IRAD was introduced into this village via the Oyili Mbenbengnyane Rural Development Common Initiative Group (CIG) through the NGO COSADAIRE. A male farmer said that he obtained the IRAD variety after participating in a training workshop organised by IRAD researchers at Nkolbison, Yaounde. The improved yellow cassava variety was introduced to farmers in the neighbouring village of Nkolfep by agroforestry researchers.

PNDRT is specialised in the Root and Tuber crop sub-sector, which is divided into production basins called antennae that consist of 250 villages, which does not include Koudandeng. PNDRT works in close collaboration with IITA Cameroon and has succeeded in distributing cassava HYV planting materials to seed multipliers in these villages (Mbairanodji, 2007). It can thus be said that, in Koudandeng, access to extension and research outreach in cassava are limited and only a few farmers are aware of and can obtain HYVs.

b) Malende

Contrary to Koudandeng, which has limited research and extension services related to cassava, the extension and research outreach are consistent and focused in Malende. Previous research (Nchang Ntumngia, 1997) showed that state run institutions of the Ministries of Agriculture and Rural Development (MINADER) and Scientific Research and Innovation (MINRESI), state corporations, donor agencies and NGO institutions intervened in Malende.

The activities of the different institutions of the Ministry of Agriculture and Rural Development are coordinated by the sub-divisional delegation of the Ministry of Agriculture for Obala, whose staff either works as ZEW or Community Development Field Supervisors/workers. Cassava HYVs are also distributed to Malende farmers through this institution. The ZEW in charge of Malende-Yoke Zone provides backstopping services in relation to cassava cultivation, farmers' organisation, and capacity building (managerial and negotiation skills). Also, farmer groups are assisted with farm tools and equipment to facilitate the attainment of their production objectives. Over 10 farmer groups exist in Malende today as a result of the long-term intervention of this institution, two of which work with the ZEW. These two groups are the Malende Women's Group, consisting of 20 members, and the Progressive Young Farmers Group, consisting of 16 members. The Community Development Field worker adopted a welfare approach and worked with women by organising them into groups where they are taught home management, cooking, and childcare, as well as linking up these groups with donor NGO institutions for assistance. An example is the Malende Women's Group, which was created in the early 1990s.

Other services of MINADER in Malende include the Provincial Cooperative Registry, and the Small and Medium Agricultural and Community Enterprises Funded Programme (Programme de Financements d'Investissements de Micro-realisations Agricoles et Communautaires (FIMAC). The Cooperative Registry registers farmers' groups into either common initiative and economic interests groups or cooperatives, whereas FIMAC grants interest free loans to farmer groups that range between one to six million F.cfa.

The main service of the Ministry of Scientific Research and Innovation (MINSREI, or MINRESI in French) that has in the past and continues to intervene in Malende are the Institute of Scientific Research for Development (IRAD) and the Cameroon National Root and Tuber Crops Improvement Programme (CNRCIP), which was created in 1981/1982 and lodged under IRAD (see section 2.3.1 for details on their activities). IRAD's activities in Malende are carried out through the various research units and projects that are located at Ekona, in Muyuka Sub-division. CNRCIP's activities in the Southwest Province are coordinated by IRAD Ekona under the following disciplines: i) Agronomy (Root and Tuber Crop Project (ROTREP)), ii) Crop Protection (Ecologically Sustainable Cassava Pant Protection (ESCAPP)), iii) Food Technology and iv) Farming Systems Research and Extension Unit (FSR/E). Except for the FSR/E unit, all other units have intervened in Malende. The ROTREP programme distributed cassava HYVs and developed and disseminated agronomic information (planting dates, weeding frequencies, planting methods, and crop associations), and processing (improving the nutritive quality of cassava processed products using soybean flour) packages to accompany the varieties distributed. The first group in Malende to have received cassava HYVs was the Malende Women's Group and later on the Progressive Young Farmers Group.

ESCAPP, which had a five-year term (1993-1997), was the African component of a bio-continental research and development activity sponsored by the United Nations Development Programme (UNDP) to promote environmentally sound cassava protection. Its objectives were: to identify major on-farm constraints to increasing cassava yields with a particular emphasis on pest, disease and weed constraints; farmers' perceptions and current plant production and protection practices; and training of farmers and extension workers in the principles and practices of ecologically sustainable crop protection, with particular reference to cassava. Through this project, biological control of farmers' cassava fields was implemented to control cassava mealybug by releasing into the air and on the ground a natural parasite called *Epidimocarsis lopezi* (a tiny wasp).

The Food Technology Unit, created in 1993 and funded by the United States Agency for International Development (USAID) with technical assistance from IITA in Ibadan, Nigeria, to address the post-harvest problems of cassava farmers, established a post-harvest training and demonstration unit located at the Food Processing Centre at Yoke (a kilometre away from Malende) in 1994. To attain its objective of promoting improved processing and preservation techniques to reduce post-harvest losses, it trained extension workers, farmers, and food processors, and demonstrated appropriate post-harvest technologies through field days. By 1997, it had trained 67 extension workers and 27 common initiative groups.

Two parastatal corporations intervening in Malende are the Cameroon Development Corporation (CDC) and the Cocoa and Coffee Seedling Project (CCSP). CDC's objective is to acquire, develop, and operate agro-industrial tropical (export crop) plantations on land placed at its disposal by the government. Even though it does not intervene directly in cassava production in Malende, it has a great influence in the economy of cassava farmers because its workers are also cassava farmers as well as purchasers of cassava products. CCSP, situated in Barombi-Kang in Kumba, is a Belgian-Cameroon Government corporation project charge with the rapid multiplication and dissemination of cocoa and coffee seedlings to farmers. From 1996 onward, it has rapidly multiplied plantain and cassava plant material and it continues to work in close collaboration with the state extension and research services mentioned earlier. Some Malende farmers indicated that they obtained some cassava plant material from this institution.

Two donor agencies that had worked in Malende in the late 1990s were the Africa 2000 Networks, which is a UNDP sponsored project, and the American Peace Corps Volunteer Service. These agencies worked in the area of sustainable production of food crops through the promotion of agroforestry practices. Field visits in 2007 identified some cassava-based polyculture fields that contained *Mucuna* spp. and *Calliandra* spp. (legume tree crops) as companion crops. Global 2000 also granted a cassava processing mill to the Malende Women's Group.

Based on the Cameroon Government's agricultural policy of promoting domestic food crop production through the encouragement of the private sector, various NGOs intervene in rural areas. In Malende, two such organisations were identified: the GATSBY Root Crop Project and the MC2/CCEI Bank.

The GATSBY Root Crop Project is a self-help programme whose objectives are to relieve poverty, fight hunger, bring prosperity and achieve a better life for all through abundant food production.[8] Its partners are: the GATSBY Charitable Foundation of the United Kingdom, IRAD, and the CEEI Bank. Existing since 1985, this project has funded research by IRAD on the development of improved varieties of root and tuber crops (cassava, yam, sweet potato and cocoyam) through IITA in Ibadan, Nigeria. GATSBY also gives grants that serve as a basis for a root crop fund to farmers' groups, which is governed by a Board of Trustees. It once organised a training session for farmers on the production of cassava and yam mini-sets (planting material produced through the rapid seed multiplication method).

MC2/CCEI Bank is a partner of the GATSBY Root Crop project in charge of managing the project funds and loan programme. To reach farmers, CCEI bank assists in organising local farmers' banks such as the MC2 Bank in Muyuka. Through this bank, CCEI guarantees rural savings and loans and integrates the Cameroon cultural practices involved in thrifts and loans known as njangi (tontine in the French Speaking Zone). Access to the MC2 bank in Muyuka is open to all farmers provided they pay a registration fee of 2500 F.cfa, an initial contribution to the capital funds of 5000 F.cfa, and a month deposit of 1000 F.cfa. Some farmer groups had actually bought shares in MC2: the Progressive Young Farmers Group and the Help Yourself Women's Group of Malende.

2.5.1.4 Agroecological potential for cassava production

Koudandeng is located in Agroecological Zone V, whereas Malende is found in Agroecological zone IV. The Southwest and Centre provinces are both tropical rainforest regions with bimodal (Centre Province) and monomodal rainfall (Southwest Province), where cassava is a major commercial and subsistence crop. These two villages are located in the cassava belt of Cameroon, considered by the Cameroon Government, AGRA and IITA (TSBF- CIAT, 2009) as a target for initiatives to promote modernisation of cassava production. The agroecological potentials of the two villages are discussed in terms of their aptitude for agriculture (climate, vegetation and soils) and farming systems.

a) Climate

Its diverse relief and morphological structure, and its closeness to the Atlantic Ocean, give Cameroon a general continental type climate and a sub-equatorial climate in the South (Etia, 1979). On this basis, two main climatic regions are identified: the equatorial climatic domain in the South, which extends between latitudes 2˚N and 6˚N, and the tropical climate domain, which extends from latitude 7˚N to 12˚N. The tropical climate domain consists of three sub-climates: the tropical humid Sudan climate, which extends between latitudes 7˚ N to 10˚ N; the Sahel climate, which extends from latitude 10˚ N; and the tropical altitude climate (Ibid.). The equatorial climatic domain is further divided into two sub-climates: the Guinea type and the Cameroon type. The Cameroon type consists of the maritime Cameroon type, which has a wet to over-wet tropical monsoon climate, and the mountain Cameroon type. While Koudandeng and Malende are both located in the equatorial regional climate, Koudandeng enjoys the equatorial Guinean type whereas Malende enjoys the maritime Cameroonian type (also called the Atlantic type).

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[8] GATSBY Root Crop Project CCEI-Bank, Bonandjo - Douala. Leaflet, 1996.

As a result of the influence of Mount Cameroon, Koudandeng, with its equatorial Guinean type climate, is characterised by two rainy seasons (mid-March to mid-June and mid-August to mid-November) and two dry seasons (mid-June to mid-August and mid-November to mid-March). It's location in the northern part of the rainforest region leads to its classification under the bimodal subequatorial rainfall cropping regimes. It has two cropping seasons which are based on the rainy seasons: the first and longer cropping season ranges from mid-March to mid-July, and the second and shorter cropping season ranges from mid-August to early November. Land preparation is usually done during the two dry seasons.

The average annual temperature ranges between 18.2˚C and 30.4˚C with the average being 25˚C. Annual relative humidity varies between 63% and 93.4%. Average annual rainfall in Koudandeng ranges between 1500 mm and 2000 mm with an average of 1310.2 mm. Except for the month of January, when there is no rainfall, rain falls throughout the year with a monthly precipitation range from 50 mm to about 295 mm. The peak amounts of precipitation are 220 mm in May and 295 mm in October. The pronounced dry season (from mid-November to mid-March) has a mean monthly precipitation of about 30mm and a minimum relative air humidity of less than 50%. The number of days of rainfall per month ranges from three in December to 24 in October. Agriculture is mainly rainfed, where off-season (dry season) market gardening crops are watered using cans or pumps (if at all affordable). There is often uncertainty about the onset of the rains for the first cropping season in March and also the occurrence of intra-seasonal dry spells in March, April or May. Long lasting dry spells (two to four weeks) cause serious damages to newly established crops. The second cropping season is short and the annual crops grown are mostly short cycled crops or varieties. The rate of evapotranspiration and solar radiation are highest with the onset of the rains in March and slightly lower in October/November at the end of the rainy season. The suitable cropping systems include: groundnuts, root and tuber crops (cassava, cocoyam, and sweet potato), maize, plantain, oil palm, cocoa, and robusta coffee. The long dry season reduces cocoa yields. Livestock grazing and rearing activities are not suitable for lower elevations because of trypanosomiasis (sleeping sickness).

Malende has the Atlantic or maritime Cameroonian type climate. It lies on a coastal lowland running along the Southeast leeward slope of Mount Cameroon, and thus has a wet tropical monsoon climate. The seasonal movement of the intertropical front and the influence of its environmental topography give it a distinct climatic pattern which consists of one long wet season that stretches from mid-March to early November, and a dry season from November to mid-March. It is classified under the pseudo-bimodal rainfall cropping regime (Yerima, 1998) that has one major cropping season and a second marginal cropping season. The monsoon wind blows in from the Atlantic Ocean through the Gulf of Guinea.

The rainfall pattern in Malende is influenced by Mount Cameroon, which forces the wet humid air masses to rise, resulting in high torrential rainfall. As a result, the short dry season that is experienced in bimodal rainfall regimes is absent, and so there is a long rainy season with two cropping seasons. However, Malende records less rainfall than the main rain-facing southwestern and western slopes of Mount Cameroon. Its average monthly rainfall is 350 mm with an annual value that ranges from 2000 mm to 4500 mm and an average of 2045.4 mm. The onset of the rainy season begins from mid-March to mid-June, then peaks from the end of June to the end of September, and ends between mid-October and early November. The peak of the rainy season is characterised by 20 days of rainfall per month with an average volume of 350 mm. Agriculture is mainly rainfed.

Malende has a very hot and humid equatorial climate with annual temperatures ranging between 22.09˚C and 32.7˚C and an average annual relative humidity range between 67.75% and 96%. At the beginning of the rainy season, the atmosphere is clear (no haze, no hamattan) with relatively high solar radiation. The high soil moisture content and relative humidity during this period makes it the main cropping season, even though farmers sow some crops twice in a year (mid-March to mid-June, mid-August to September). During the peak of the rainy season, there is continuous rainfall and very cloudy weather, with only about two hours of sunshine per day. The onset of the dry season is characterised by a covering of haze and hamattan dust that blows in northwards from the Atlantic Ocean and daily sunshine of four to five hours. Even though the amount of rainfall favours high crop productivity, the variation in atmospheric conditions during the cropping seasons is not ideal for crop production in all periods. For example, with respect to the first cropping season (mid-March-June), crops planted at the onset of the rainy season are faced with decreasing rainfall and solar radiation, which increases the risks of failure of crop establishment and growth. Such crops are also harvested in the midst of the peak of rainfall, which creates harvesting and transportation difficulties for farmers. Late planting of crops reduces the risk of crop establishment failure, but leads to longer growing periods, lower yields, and serious harvesting problems due to excess humidity and high incidence of pests and diseases. The limitations of the second cropping season (mid-August-mid-September) are: planting is done in the middle of a very wet period (peak rains) in the rainy season, when the incidence of pests and diseases is high and there are risks for crop establishment due to water shortage with premature rain cessation in October.

Despite the fact that the moist orographic clouds prevent the occurrence of cloudless bright sunny days which limits the rate of evapotranspiration, the general presence of good moisture conditions and limited levels of solar radiation provide favourable environments for root and tuber-based cropping systems (such as cassava, cocoyam, yams) and for suitable perennial crops such as oil palm, rubber, cocoa, and banana. Robusta coffee is grown at elevations above 1000 m. The climatic regime favours tsetse fly, which causes sleeping sickness and makes the zone unfavourable for grazing cattle, goats, and sheep.

b) Relief (topography)

Malende and Koudandeng both fall within the Southern geographical region of Cameroon, which is characterised by the existence of a coastal plains about 40 km wide and the densely forested plateau with an average elevation of about 600 m above sea level. Koudandeng falls within the densely forested plateau and lies specifically within the forest savannah transitional zone (Gillison, 2000; Sonwa et al., 2008[9]), with an altitude of about 700m above sea level. Its landscape is dominated by gently undulating hills with convex slopes that have altitudes reaching 1200 m above sea level. It is located within the River Sanaga Water Basin (source: see footnote 7). Malende falls more on the borders between the coastal plains

[9] Sonwa, D.J., Nkonmeneck, B.A., Weise, S.F., Tchata, M. and M.J.J. Janssens. 2008. Chocolate Forest and the Peri-Urban Landscape: Tree diversity of the cocoa agroforests around Yaoundé (southern Cameroon). *Sustainable Tree Crop Program (STCP) Working Paper Series*. Issue 5. http://www.treecrops.org/newsandevents/AEFAT_biodiversity_cocoa_Af_Yaounde_fringe_WPIssue_5_Jan_08.pdf

and the densely forested plateau and lies on the Northeast leeward side of Mount Cameroon, between latitude 4.3˚N and longitude 9.367” E. It is coastal lowland with an altitude of 400 m above sea level (Nasa Goddard Space Flight Creater, Folack and Gabche, 1997)[10]. It receives fluvial soil deposits from the Moungo River and runoff from Mount Cameroon.

c) Soils

According to Vicat (1998), geological and tectonic analysis work within the last fifteen years differentiates five main structures that form the base of Cameroon’s soil types: the craton (stable part of the earth’s crust), the craton cover, the Panafrican chain, sedimentary basins and the Cameroon line. According to Vicat’s description, Koudandeng falls within the Yaounde series of the Panafrican chain that is made up of metamorphic and magmata rocks. The Yaounde series consists of 2-mica micaschists, granite, kyanite or cyanite (mineral aluminium silicate $A_2SiO_{5)}$, staurotide, quartz, igneous, mica (silicate) and magmata. Based on a combination of the FAO-UNESCO and USDA soil classification systems, Koudandeng soils fall within the Udic soil moisture regimes and are haplic ferralsols (Yerima, 1998). Based on the USDA classification system, Gockowski et al. (2004) and Madong à Birang (2004) classify the soils of Nkometou (a village neighbouring Koudandeng) as the phodic kandiudult type, which may also contain some alluvial soils since they lie around Sanaga River. Koudandeng’s soils are considered among those with the highest agricultural potential among ferrasols and medium value dystric nitisols (ultisols) that are subject to erosion and that are nonetheless preferred to ferrasols for the cultivation of food crops, since they do not have the soil acidity problems that characterise most ferrasols. They are good for the production of oil palm, cocoa, cassava, groundnut, maize, cocoyam, yam, sweet potato, plantain, banana, and tropical vegetables (Yerima, 1998; Gockowski et al., 2004). Cocoyam is of relative importance and robusta coffee is not much grown.

Malende falls within the Douala Basin of Rift Valley sedimentary rocks (Vicat, 1998). An analysis of Ngana Njike’s study (1984) of Cameroon’s Atlantic Basin reveals that Malende actually falls on the borders of the Kumba-South conglomerate that constitutes part of the Moungo series and that is located within the Douala Basin. Its geological composition from bottom to top consists of average size white sandstones that are rich in feldspar, quartz, and carbonate; sandy clays that are interspersed with sand; poorly consolidated sandstone; and stratified dark colour mica-silt-clay (fine grain sediments of mud and clay particles) that are layered and rich in organic matter (plant and lignite-brown coal). These are covered at the top by a thick layer of poorly consolidated sandstone, which is superimposed by layers of clay sediments composed of mountain and delta deposits. These soils fall within the category of alluvial soils and thus are fluvisols (Yerima, 1998) that also have deposits from the andosols (volcanic soils) of Mount Cameroon. Malende’s soils are considered to be a combination of dystric glycols, district fluvisols and andosols, and are good for the production of rubber, industrial and smallholder oil palm, cocoyam, taro, cassava, banana, robusta coffee, cocoa, plantain, and colocasia (taro). Groundnut and maize are of relative importance. These soils are classified among the most fertile for agriculture because the constant deposition of debris from runoff water increases the amount of plant debris and gives these soils a thick soil organic matter structure and biomass that facilitate the cycling of plant nutrients such as nitro-

[10] http://www.tageo.com › Cameroun. Accessed 20/05/2010.

gen and phosphorus, and large proportions of base nutrients such as potassium, calcium and magnesium. The Muyuka Sub-division, to which Malende belongs, is considered as the breadbasket of Fako Division.

Soil temperature and moisture also determine agricultural potential. In relation to soil moisture, Malende and Koudandeng both fall within the udic soil moisture regimes, where soils are not dry for about 90 days cumulatively in a year, and soil use is diversified according to elevation above sea level and mean temperature (Ibid.). Malende falls within the first transition of the elevation that ranges between 300-400m above sea level, whereas Koudandeng falls within the second transition of the elevation that ranges from 800-1000 m above sea level.

In Cameroon, the Isohyperthermic and Isothermic are the main soil temperature regimes that are important for agriculture. Malende and Koudandeng both fall under the Isohyperthermic soil temperature regimes, where the mean soil temperature is above 22˚C. The location and elevation of these two villages determine the variation in mean annual soil temperatures. Malende has a Mean Annual Soil Temperature (MAST) of 28˚C, and Koudandeng has a MAST of 24 - 25˚C. These soil climatic factors provide favourable condition for plant photosynthesis and are good for the production of tuber crops and suitable perennial tree crops.

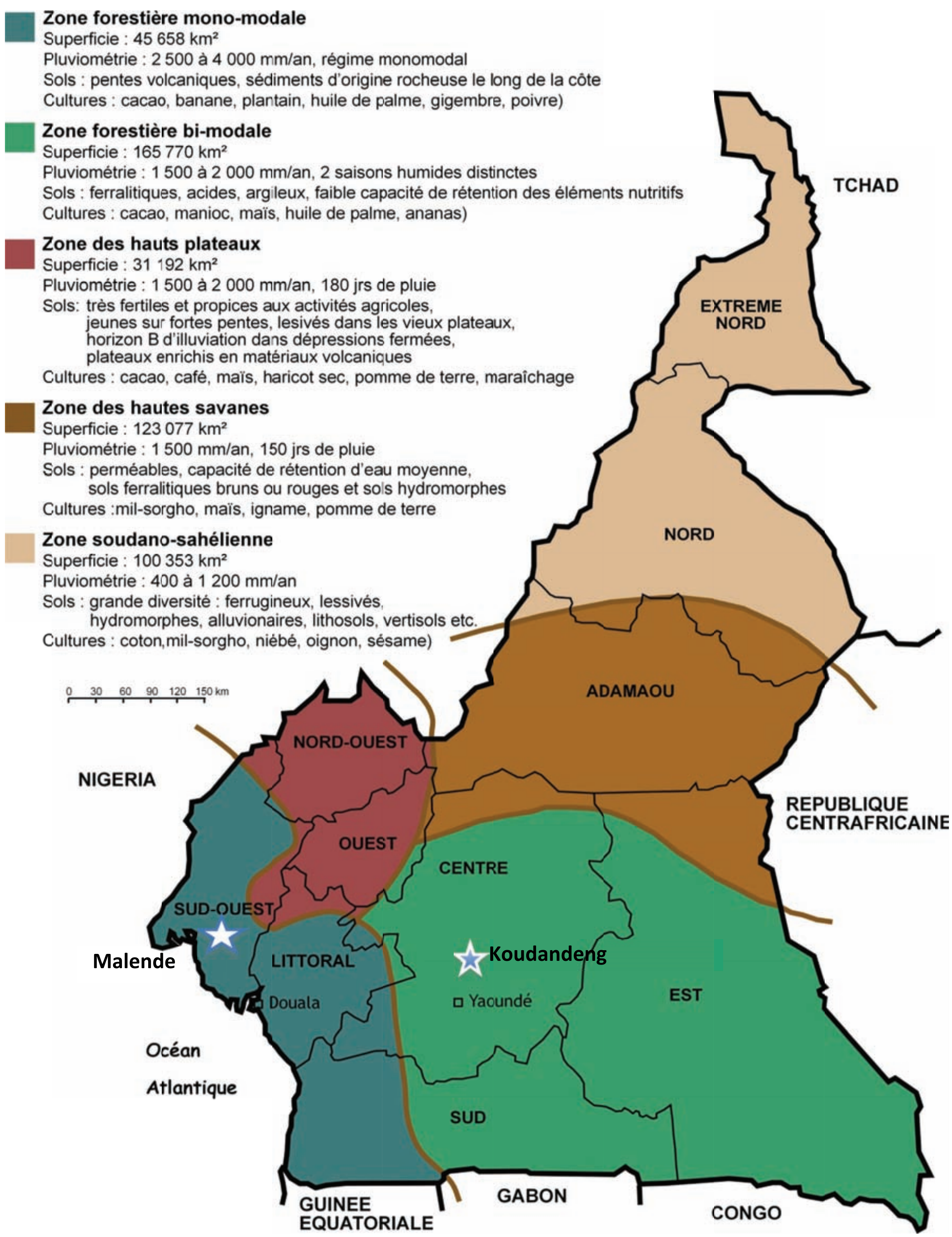
d) Vegetation

Humidity is a determining factor in the development of vegetation and thus major vegetation zones generally follow climatic regimes; however, this correspondence is distorted in cases where relief, soils, and man intervene (Yerima and van Ranst, 2005). Two major vegetation zones can be distinguished in Cameroon, with a gradual change from one zone to the other: dense equatorial forest and tropical grasslands. The dense equatorial forest consists of mangrove forest, rainforest, and mountain forest (relics) and savannas. Koudandeng and Malende both fall within dense equatorial forest. Humans have, over time, exerted great influence either through agriculture (plantations, food crops), timber exploitation or urban expansion, and thus primary forests have been transformed into secondary forests with faster growing tree species and large-leafed grasses.

Koudandeng lies in the forest savannah transitional zone of the rainforest region and now has a more or less semi-deciduous type of vegetation instead of primary evergreen forest. Its vegetation presently is degraded semi-evergreen Guinean-Congolese forest with mixed patches of fragmented evergreen rainforest[11] that border other forms of land use: fallow vegetation, farmland, and human habitats. The vegetation and land use structure of Nkometou and its surrounding villages (among which is Koudandeng) are as follows: 25% is under crop, 29% is under fallow, and 25% is under forest cover (Madong à Birang, 2004). Malende lies on the borders of the mangrove forest and the rainforest regions. It also benefits from mountain forest deposits. Mangroves, rainforests and deposits from Mount Cameroon influence its vegetation cover. Its vegetation alternates between evergreen and deciduous forest to savannas (Etia, 1979; MINADER, 2003a). Cameroon’s diverse climate, soils, and vegetation led to the designation of the five major agroecological zones that are depicted in Figure 2.1.

[11] Source: see footnote 7.

Figure 2.1 Agroecological Zones of Cameroon and the Study Area



Source: Document de Stratégie de Développement du Secteur Rural (SDSR), Cameroun

As discussed above, Malende falls under the pseudo-bimodal rainfall cropping regime that has one major cropping season from mid-March to mid-June, and a second marginal cropping season from mid-August to mid-September. Koudandeng falls within the bimodal equatorial rainfall cropping regime that has two distinct cropping seasons, ranging from mid-March to mid-June and mid-August to mid-September. Falling under the same soil moisture regime, Koudandeng and Malende tend to have similar crops that are nevertheless produced in varying intensity and in different cropping systems. The two main types of farming or cropping systems are monoculture and swidden polyculture. The only livestock reared is the pig. Hunting of wild game using traps and strings is common in Koudandeng.

Monoculture systems are either plantations of permanent crops or semi-permanent crops such as plantain/banana, or of short cycle annual crops. Plantations are either large scale industrial plantations or smallholder plantations. Large industrial plantations exist in Malende where the Cameroon Development Corporation (CDC) established its oil palm and rubber plantations. Smallholder plantations include oil palm, banana, and cocoa, which are managed by a few male farmers. Koudandeng farmers mainly manage smallholder older cocoa plantations in monoculture. Oil palm, banana/plantain, and newly created cocoa fields are mostly managed in polyculture.

Traditional farming systems tend to follow the rainfall patterns and are predominantly polycultural. While polyculture systems predominate in Cameroon's Forest Margin Bench Area (FMBA), of which Koudandeng forms a part, monoculture systems in this region are more oriented towards commercial production in those areas that have good market access (Gockowski et al., 2004). However, in Koudandeng, where food crop production is more oriented towards subsistence, current analysis of the farming systems shows that market orientation is not the only factor that determines whether a crop will be grown in monoculture or polyculture. Rather, the nutrient requirements of plants and the nature of plant-plant interactions determine whether fields are planted in monoculture or polyculture, especially in relation to annual crops. However, vegetables (tomato, onion) and green leafy condiments and spices are grown in monoculture for sale.

There is a similarity among farmers in both villages in that they manage many different polyculture fields, where differences occur in relation to the combinations of the intercrops. The diverse food habits and crops of these farmers, as well as the market demands for specific crops, influence the establishment of numerous field types. These field types are established on one or more plots where farmers practice fallow rotation. Survey data collected during field research show that an average Koudandeng household manages 1.97 (std. = 0.674) plots, and an average Malende household manages 2.07 (std. = 0.83) plots. Table 2.5 depicts the number of plots managed per household in both villages.

Table 2.5 Total Number of Plots per Household

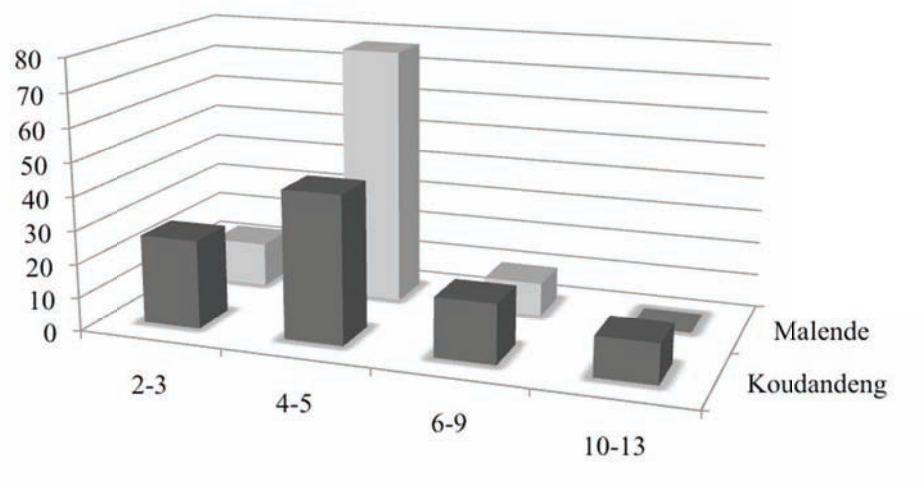
Number of Plots Managed	*% Households in Koudandeng N = 34*	*% Households in Malende N = 30*
1	20.6	26.7
2	64.7	43.3
3	11.8	26.7
4	2.9	3.3

2.5.2 Farming or Cropping Systems

Koudandeng farmers seem to grow their crops most often in two plots that are subdivided into fields, whereas Malende farmers tend to manage between one and three plots that are not necessarily subdivided into fields (Figure 2.2). On average, 5.47 (std. = 2.79) and 4.23 (std. = 1.07) fields are managed in Koudandeng and Malende, respectively. The difference is significant ($p < .05$). The proportion of households managing between three and eight crop fields is more evenly distributed in Koudandeng relative to Malende, where over 50% of the households manage four fields. Field sizes in Malende are generally larger than in Koudandeng. This may be due to the fact that Malende farmers use more hired labour, whereas Koudandeng farmers depend more on own and family labour.

Sub-division of plots into fields in Koundandeng is not explained by larger plot size or larger overall landholdings, since total holdings in Koudandeng are smaller on average than those in Malende. The difference in average holding size between the two villages is significant ($p< .001$), as shown in Figure 2.2.

Figure 2.2 Number of Fields Managed by Village



	2-3	4-5	6-9	10-13
Koudandeng	26.47	44.12	17.64	11.76
Malende	13.3	76.6	10	0

Malende is located along the Buea-Kumba Highway, and the oil palm and rubber plantations of the Cameroon Development Corporation (CDC) occupy most of its land. Therefore, most smallholder plantations and food crop fields are located outside the village at quite a distance. Increasingly, farmers' fields are found along the Moungo River (which separates the Southwest and Littoral provinces) and in the Mile 40 Government Forest Reserve (along the Buea-Kumba Highway). Travelling such distances to fields is facilitated by the highly developed rural transport system within the entire Muyuka Subdivision. Small vehicles commonly called "Opep" (unregistered taxis) and motorbikes are the main means of transport for farmers. Motorbikes are much used because they can easily access rough (with bulging tree roots, felled tree trunks) and muddy/marshy field tracks. Because of this transport system, farmers often use time estimates (minutes, hours) as a measure of distances to fields rather than metres or kilometres. The time estimate for distances to fields ranges between 10 minutes for those in the village to three hours for those on the Moungo River.

Koudandeng is located more in the hinterland, further away from the Bafoussam-Yaounde Highway, and is surrounded by many villages. Its rural transport network (especially home to field transport) is not as highly developed as that of Malende. Koudandeng farmers mostly walk to their fields and use both time estimates and kilometres as measures of distance. The use of rural transport (bikes, small vehicles) to distant fields depends on their availability and the time of day. Distances to fields in Koudandeng are shorter than those of Malende. The time estimates when walking range from 10 minutes to two hours and the metric estimate of field distance range from 500 metres to eight kilometres. The furthest fields (about eight km) are located on the boundary with Nkoldobo (Koudandeng's ancestral village), especially along the main river that separates the two villages. A sacred spot on this river, called Samnwolo, is reserved for the performance of ancestral rites and rituals.

Whether the fields are at short or long distances, they are mostly polyculture fields, which contain varied combinations of crops. Manyong et al. (1996) indicated that, in polyculture systems across the Central African region, the crop used to designate the system is that which is the most important. However, instead of referring to the 'importance' of a crop, the term 'meaningfulness' of the crop to farmers is preferred. For example, when a Koudandeng farmer speaks of a groundnut field, he/she actually refers to a groundnut/cassava-based cropping system where cassava, groundnut, leafy vegetables, plantains, and cocoyam are intercropped. These are the main cassava fields. This has often led researchers and rural development interveners to think that all of the other associated crops in the polyculture fields are not important and should therefore not be included in the evaluation of productivity in traditional farming systems. Rather, researchers and development agents should refer to a combination of crops to designate a field type or cropping system.

In addition, fields can be classified according to the sex of the manager. The traditional gender divisions of roles, where women are responsible for providing food for their households, led to the general designation of all crops that women manage as women's crops. Consequently, the fields in which these crops are grown are also called women's fields. Traditional men's fields are more related to tree crops such as cocoa, oil palm, and robusta coffee. However, the commercialisation of some domestic food crops has led men to also take up their production. The traditional belief, which dates back to the pre-colonial era, considered women to be weaker than men, so it was thought that they could not carry out agricultural activities that require heavy energy expenditures such as clearing and digging holes for planting palms and cocoa. According to these beliefs, women's crops did not require heavy energy expenditures. Also, trees are planted to secure land and thus tree planting was seen as a man's responsibility since men traditionally owned land.

The types of cropping systems that were identified in the two villages are found in tables 2.6 and 2.7. There are also notable differences in field size between women and men's traditional fields. The size of men's food crop fields range between 0.5 and 4 ha, with an average of 1.35 ha ($\sigma = 1.482$), whereas the size of women's ranges between 0.25 and 3 ha, with an average of 1.03 ($\sigma = 1.126$). The size of tree crop fields ranges from 1 to 10 ha.

The gender division of crops and cropping systems in Koudandeng is distinct from that in Malende, where the gender divisions in food crops and cropping systems are not so strict. However, mainly men manage tree crops in both villages, which may be related to the traditional norms where tree planting confers land ownership. In Koudandeng, women are increasingly managing egusi (melon) and banana/plantain fields that were traditionally managed by men, while a few men also manage groundnut-cassava and cocoyam-based systems that were traditional women's domain. Two men were found who manage the yam-based system (specifically calaba yam, which is an exotic variety). Some widows inherit and manage cocoa-based systems.

There is a greater diversity of crops in Koudandeng fields compared to Malende fields. For example, the typical cassava-based polyculture field in Koudandeng has on average seven crops and in Malende it contains four (tables 2.6 and 2.7). A detailed discussion of this diversity is presented in tables 4.1 and 4.2 in Chapter 4.

2.5.3 Livelihoods and Access to Production Resources

This section discusses the economic dynamics of Malende and Koudandeng in terms of livelihoods, access to production resources (land and labour access), and market orientation and participation in cassava production and processing, and demonstrates why these two villages are representative of the types of cassava production systems that are found in Cameroon. Koudandeng farmers are engaged in small-scale cassava production but generally are not land or cash constrained and most farmers depend mostly on own or family labour. Malende farmers are engaged in small-scale cassava production but are generally not cash or labour constrained, and only some farmers are moderately land constrained.

2.5.3.1 Livelihood strategies

Livelihood strategies and options in Koudandeng and Malende are complex and diverse. These options include agriculture and other income earning activities. In relation to income generation, households have various sources that range from the sale of food crops and processed food products through petty trading of agricultural goods, sale of agricultural labour and labour for food processing, land rental, sales of wild food plants, managing beer and provision shops, professional activities (sewing, hair dressing, carpentry, plumbing), salaried employment (nursing, driving), and transfer payments (pensions, remittances). A detailed discussion of these livelihood options in Chapter 6 (tables 6.11 and 6.12) highlights the fact that, except for professions such as hair dressing, food milling, beer vending, and salaried jobs (nursing, pension, and driving) that provide some 50% or more of total income for 23% of the households, 77% of Koudandeng households derive the largest proportion (51.5%) of their income from agriculture. In the case of Malende, 13% of all cassava-producing households earn over 60% of their income from teaching, clothing sales, or sales of household provisions, and 87% of households depend on agriculture for the majority of their income (> 60%).

Women have usufruct rights to land for agriculture but cannot plant tree crops. "In the days of our forefathers, the girl child and women were considered a weaker sex and so had no voice in decision making. There was little or no regard for women," explained Papa Bonaventure (born in 1929). Even though the sons of unmarried daughters (traditionally called ungungwane) are considered to be members of their mothers' natal family and so have rights to inherit through their mothers' lineage, they are entitled to a smaller share of land relative to the share received by their mothers' brothers. Widows who decide to move back to their natal kin traditionally have usufruct right to land that belongs to their natal kin but, increasingly, men are viewing this tradition as unjust as well as a threat to them because of the existence of conflicts and competition over family land. The only situation where daughters can inherit landed property from their fathers, even when married, is when they are lone children or have lost all brothers. In this case, the larger family deliberates on this in a meeting. If a lone daughter has a son, he immediately becomes the heir. "I have inherited my mother's father's cocoa fields and land because my mother gave birth to me before coming into marriage in this village. I have so much land," explains Paul (43 years old). I have also inherited my maternal grandfather's land and cocoa fields. While I am considered a stranger in this village, I am not a stranger in my mother's natal village and family," explained Pierre Celestin (33 years old).

It is culturally unacceptable for women to buy land but, due to increasing demand for land for agriculture, women are purchasing it. At the time of this research, one woman was identified in Koudandeng who bought farmland, but she handed it over to her husband to avoid criticism from her husband's kin and others. Previous research in Malende showed that women who purchased land face confrontations with their husbands who want to claim ownership over such land (Nchang Ntumngia, 1997).

Temporary ceding of farmland by family and friends and land inheritance are the forms of access that existed in the pre-colonial era, but increased commercialisation of land has led to more diverse forms of access. In relation to the sample population studied, five major types of access were identified: inherited, temporarily ceded by friend or family, purchased, rented, and sharecropped. Renting and sharecropping do not exist in Koudandeng. The commercialisation of farmland in Malende also tends to lead to larger holdings in comparison with Koudandeng, and is evident in land tenure (Table 2.8). Total holdings in Koudandeng are smaller on average than those in Malende. The difference in average holding size between the two villages is significant (p< .001), as seen in Figure 2.3.

Figure 2.3 Total Land Holdings per Household in Koundandeng and Malende

Koudandeng

Malende

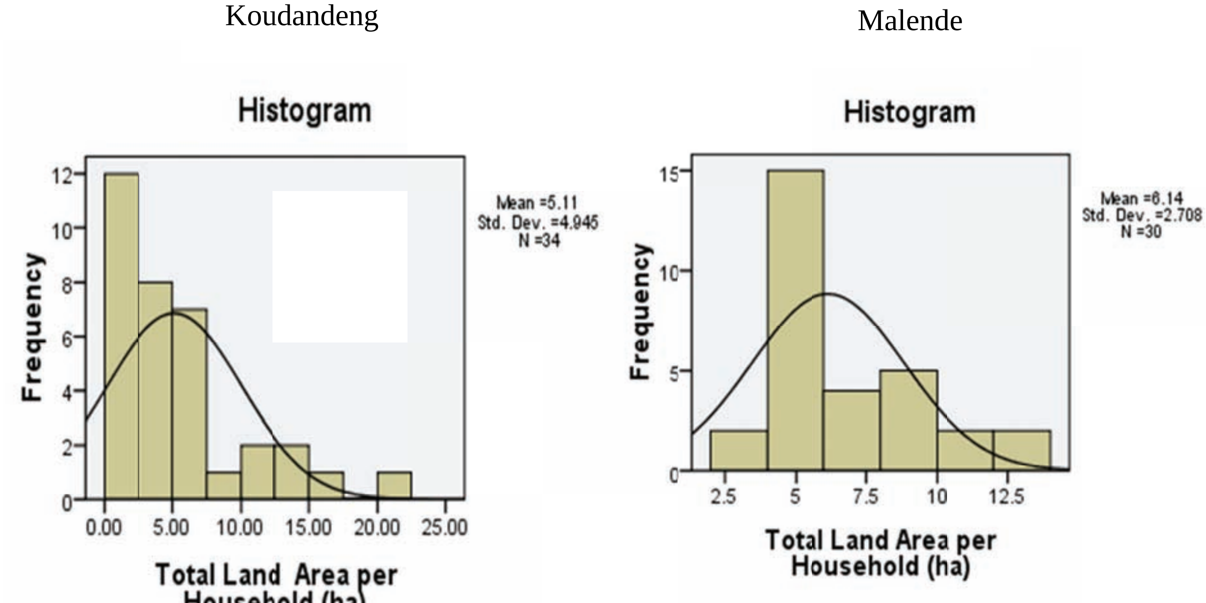


Table 2.6 Koudandeng Cropping Systems by Sex of Manager

Sex of Manager	*Cropping system*	*Avg. Field Size (ha)*	*Cropping System (Pattern)*	*Intercropped Crops*	
				Major Crops	*Minor Crops*
Traditional Men's Fields	Cocoa-based	1.3	Monoculture (> 20 yr. old fields)	Cocoa	
	Cocoa-based	0.66	Polyculture (young fields)	Cocoa, orange, plantain, oil palm, avocado, mango, African plum, banana	Bitter kola, okra, cassava, njangsa, yam, mandarine, maize
	Orchard	1.5	Polyculture	African plum, mango, orange, avocado	Oil palm, mandarine
	Oil palm-based	2.0	Polyculture	Oil palm, mango, African plum	
	Parsley, celery, onion	0.08	Monoculture	Basil (parsley), celery, onion	
	Tomato	0.1	Monoculture	Tomato	
		0.2	Polyculture	Tomato	Plantain, pepper, mango maize, African plum
	Green leafy vegetables	0.03	Monoculture	Greens	
			Polyculture	Greens, Pepper	
	Calaba yam	0.1	Polyculture	Calaba yam	Berries, sweet potato, cassava
	Maize	1.0	Monoculture	Maize	
		1.0	Polyculture	Maize and Cassava	African plum, avocado, mango, cocoyam
	Plantain/ banana	0.66	Polyculture	Plantain, and Banana	Cassava, cocoyam, groundnut, African plum
	Egusi		Polyculture	Egusi (melon)	Plantain, cassava

Table 2.6 Koudandeng Cropping Systems by Sex of Manager (con't.)

Sex of Manager	*Cropping system*	*Avg. Field Size (ha)*	*Cropping System (Pattern)*	*Intercropped Crops*	
				Major Crops	*Minor Crops*
Traditional Women's Fields	Groundnut-Cassava-based	1.2	Polyculture	Groundnut, cocoyam, cassava, plantain, maize, green leafy vegetables, okra	Sweet yam, egusi, banana, onion, sesame, pepper, berries, sugar cane
	Cassava-based	0.15	Monoculture	Cassava	
		0.3	Polyculture	Cassava	Groundnut, maize, cocoyam, green leafy vegetables, plantain, okra
	Cocoyam - plantain	0.25	Polyculture	Cocoyam, Plantain	Maize, banana, pawpaw
	Sweet Potato	0.15	Monoculture	Sweet potato	
		0.17	Polyculture	Sweet potato	Banana, ii) cassava, iii) green leafy vegetables, iv) maize, v) groundnut
	Beans	0.08	Monoculture	Beans	
	Soy beans	0.08	Monoculture	Soy Beans	
	Green Leafy Vegetables	0.1	Polyculture	Green, bitter leaf, pepper, okra	
	Plantain/ banana	0.25	Polyculture	Plantain, banana, cocoyam, cassava	Cocoa
	Maize	1.2	Monoculture	Maize	
		0.1	Polyculture	Maize	Plantain, Sweet potato, Sesame, Cocoyam
	Egusi (melon)	0.25	Polyculture	Egusi	Cocoyam, plantain, maize

Source: Freelisting data, Household survey and Cassava survey

Table 2.7 Malende Cropping Systems by Sex of Manager

Sex of Manager	*Farming system*	*Average Field Size (ha)*	*Cropping System (Pattern)*	*Intercropped Crops*	
				Major Crops	*Minor Crops*
Men's Fields	African plum-based	1.1	Polyculture	African plum	Pineapple, plantain
	Citrus-based	1.25	Polyculture	Orange, grapefruit, lemon	
	Coffee-based	1.5	Monoculture	Coffee	
	Orange-based	1.25	Polyculture	Orange, plantain, pineapple	African plum, oil palm
	Pineapple-based	1	Polyculture	Pineapple	Plantain, cocoa
	Oil palm-based	2.2	Polyculture	Oil palm, pineapple	Orange, plantain, African plum
		2	Polyculture	Oil palm, cassava	Cocoa
	Cocoa	2.3	Polyculture (young fields)	Cocoa, plantain, orange, oil palm	Coffee, African plum, mango pineapple, lemon, avocado,
		2	Polyculture (young fields)	Cocoa	Cassava, egusi, cocoyam, maize
Women's Fields	Green leafy vegetables	0.1	Polyculture	Huckleberry, green leafy vegetables	Okra, Okongobong
	Groundnut-maize- cassava-based	1	Polyculture	Groundnut, maize, cassava	Sweet potato, cocoyam, egusi
	Sweet potato	0.25	Monoculture	Sweet potato, cocoyam, egusi	
	Tomato	0.1	Monoculture	Tomato	
	Colocasia (taro)	1.75	Monoculture	Colocasia (taro)	

Table 2.7 Malende Cropping Systems by Sex of Manager (con't.)

Sex of Manager	*Farming system*	*Average Field Size (ha)*	*Cropping System (Pattern)*	*Intercropped Crops*	
				Major Crops	*Minor Crops*
Fields managed by both men and women	Cassava-egusi-maize-based	1.316	Polyculture	Cassava, egusi, maize, groundnut	Cocoyam, colocasia, water yam, plantain, oil palm, sweet potato, sweet yam, water yam, green leafy vegetables, banana
	Cocoyam	1	Polyculture	Cocoyam, maize, Groundnut	Egusi, cassava, colocasia, green leafy vegetables, plantain
		1	Monoculture	Cocoyam	
	Egusi - cassava	1.318	Polyculture	Egusi, cassava, maize	cocoyam
	Maize	1.368	Monoculture	Maize	
		1.2	Polyculture	Maize, egusi	Cocoyam, cassava, Koki beans, groundnut
	Plantain	1.43	Polyculture	Plantain, cocoyam	Cassava, groundnut, oil palm, yam, maize, colocasia, egusi
		1	Monoculture	Plantain	
	Sweet Yam	0.25	Polyculture	Sweet yam, water yam	Egusi, maize, sweet potato
	Water yam	0.25	Polyculture	Water yam	Plantain, sweet yam, cocoyam, Okongobong
		0.3	Monoculture	Water yam	
	Calaba yam	1	Polyculture	Calaba yam, egusi	Maize, groundnut, plantain, sweet yam, cocoyam, colocasia

Source: Freelisting data, Household survey and Cassava survey.

Table 2.8 Land Tenure in Koudandeng and Malende

Land Tenure	*Koudandeng*		*Malende*	
	% Fields Acquired (N = 118)	*% Households Managing (N = 34)*	*% Fields Acquired (N = 116)*	*% Households Managing (N = 30)*
Inherited	61.0	65.8	23.7	29
Ceded by Friend to Use	19.5	36.8	5.3	6.5
Ceded by Family to Use	10.2	26.3	7.9	9.7
Purchased	9.3	13.2	34.2	41.9
Rented			31.6	38.7
Sharecropped (caretaker or two parties)			10.5	12.9

Source: Household census data 2002-2003; Household survey, 2007

Most Malende farmers are migrants who rent farmland from native owners. Some migrants who have lived in Malende for over 10 years have also purchased farmland, but some of those who have purchased continue to rent fields to grow annual crops. In Koudandeng, farmers generally depend more on land inherited from their fathers and, to a lesser extent, on land ceded by friends and other relatives.

Very few (9.3%) have purchased land, although some who have purchased land also have inherited it. Traditionally, family land is shared among male siblings, whereas female siblings have usufruct rights to grow annual crops. As such, the size of landholdings per household has decreased over time, especially in large families that have many male children, which provides the incentives for males to purchase additional land.

Friendship and kinship ties that lead to access to land for crop production are stronger in Koudandeng than in Malende, where land is more commoditised. Another form of access to land for agriculture that is developing in Malende is sharecropping (commonly called 'care taker' or 'two parties' systems). This form of tenure is mostly possible with respect to cash crops such as oil palm and cocoa, where farmers who manage such fields share the proceeds with the landowners. The managers also take advantage of any unused land to grow annual crops for own consumption and/or sale. The landowners are mostly absentee, living outside of Muyuka Sub-division (to which Malende belongs).

2.5.3.3 Access to labour

Farmers organise their labour (effort and time) to be able to manage the different activities that must be done during specific periods of the year. As discussed in chapter 6, labour has been identified as an important limiting factor in cassava production (cultivation, processing, and marketing) in both villages. The five main strategies to access labour in the study area are: labour sharing, family labour, individual farmers' time organisation, commercialisation of labour, and the use of labour-saving devices in processing (cassava mills, graters).

Labour sharing is the act of mobilising other persons' labour with the intension of sharing or splitting the amount of effort and time that an individual invests in specific activities by an individual. Labour sharing can be mobilised either through negotiation or by imposition. Mobilising community, group, and family labour are the three forms of labour sharing identified in this study. Community labour mobilisation is more common in Malende than in Koudandeng. Group labour includes temporary labour exchange groups, permanent farmer groups, and social ethnic groupings. Labour exchange among members of these groups does not require the payment of money and most of these groups sell out their labour to non-members.

The seasonal availability of labour, which varies with the cropping calendar and farming seasons and especially during peak farming activities (weeding, land preparation), has increased the demand for hired labour and the number of people who sell their labour in both villages. Clearing thick bushes and felling trees, especially if the fields are long duration fallows or forest vegetation, requires high-energy expenditure and therefore hired male labour is used. Frequent processing of huge volumes of cassava especially for sale has also increased the use of hired labour, especially in Malende. Malende seems to use hired labour more compared to Koudandeng.

2.5.4 Cultural and Demographic Dynamics of the Two Villages

Koudandeng has a more homogeneous ethnic composition with long-term natives and maintains more its traditions compared to Malende, which has a heterogeneous ethnic composition composed of migrants (87%) and native Balong speakers (13%).

2.5.4.1 History and settlement patterns

Koudandeng and Malende have quite distinct histories and settlement patterns that influence contemporary cultural dynamics in the two villages. The people of the Etone tribe, the residents of Koudandeng, believe that they migrated from Mbam Division of the Centre Province, crossing the River Sanaga on the back of their Totem Spirit or deity called *Ngomedjap*. They settled in the area that lies South of the Sanaga River, which is now Lekie Administrative Division. People first settled in small groups that have now grown into five major clans: the Esselle, Mbokani, Etom, Mendoum, and Mvog Nname. The Esselle clan, of which Koudandeng residents are a part, first settled in Nkoldobo village, which is part of the area that now constitutes Okolla Sub-division, and later on came to occupy the area that now constitutes Obala Sub-division as a result of population increase and disputes among the five sons of Esselle (Anguimbassa, Ayibissangne, Menye Asanga, Andjougho, and Assolo), whose descendants constitute the five lineages of the Esselle Clan. Administratively, Koudandeng falls within Obala Sub-division.

The lineage of Anguimbassa, the eldest son of Esselle and his four sons (Ebene, Etongounou, Atengnepeu, and Obesse Anaba) who made up the major family groups, came to occupy the land that constitutes Koudandeng, Nkolfepe, Endinding, and neighbouring villages. Ebene and Etongounou settled in Koudandeng and formed smaller lineages called Mvog Ebene and Mvog Etongounou. In Etone culture, family groups are termed *mvog*, meaning "family of". Mvog Ebene is the largest and makes up what today is called 'big Koudandeng', while Mvog Etongonou, younger brother to Mvog Ebene, has a smaller group that constitutes what is called 'small Koudandeng'. Birth order is the factor that determines social rank in the culture of the Esselle Clan. These large family groups formed smaller family groups and then households. The settlement pattern in Koudandeng respects this order of family groupings. Mvog Nobene and Mvog Ayibene are the two major family groupings in big Koudandeng, and the smaller groupings are: Mvog Ayissi Bene, Mvog Lemangeume, Mvog Atangnempeu (descendants of Ayibene), Movg Nomolo, Mvog Ayi Molo, and Mvog Nemelo (the descendants of Nobene). The Mvog Nomolo family group holds the chieftaincy and the first Chief of the village was Enounga Gabriel.

According to Papa Bonaventure (family head of the mvog Nomolo family group, born in 1929), Koudandeng village was established by a Catholic mission that was set up in 1912 and that was finally built in 1964. The ancestors of the main lineages and family groups came in search of Christianity. The members of the two lineages settled in small isolated units in the forest that were distant from the Catholic mission but, with encouragement from the missionaries, they moved out of their former settlements and settled along the main road.

The native Balong speakers of Malende were believed to have migrated from Manenguba in Kupe Manenguba Division in the Southwest Province, and settled in Manyemen (upper Balong) due to inter-tribal wars. Continuous inter-tribal wars, coupled with the infertile soils of Manyemen, forced many settlers to migrate eastwards and southwards in search of peace and more fertile farmland. Those who moved southwards were the children of one father who settled in Malende, Yoke, Muyuka, and Mile 30. The Mile 30 group later on migrated to Mpundu and Bai. The Malende group first of all settled in the eastern part of Malende along the Mungo River, which was the main transport line used for the shipment of timber, cocoa, and bananas from Laduma and tobacco from Malende to the then Victoria Seaport, which is currently known as Limbe Seaport. The construction of the Victoria (Limbe)-Kumba trunk "A" road and the kidnapping of natives' daughters by their Douala neighbours in the early 1960s led to the establishment of the present settlement site, which lies on the western part of the Mungo River. The natives occupied the northern part of Malende, towards the Mile 40 border with the southern Bakundu Government Forest Reserve.

Apart from the natives of Malende, immigrants also settled here. According to the village Chief, the first migrants came in 1940 to work for the German Road Construction Company and for the Malende Tobacco Farm, which was situated along the Mungo River. Later on, more migrants came in search of fertile farmland, while others came to work on the rubber plantations belonging to the Cameroon Development Cooperation (CDC). Migrants from Nigeria (which neighbours Cameroon) came as traders selling clothing, rice, crayfish, fish, and gari in Muyuka's market, which was the only market in the region. The early migrants were the Douala, Bassa, Bayangi, and some Nigerians who (especially the workers) settled in the camps and along the Mungo River. The next lot of migrants, especially farmers, settled in the central and southern parts of Malende, areas that were occupied by elephants that destroyed the natives' crops. The need for fertile farmland and job opportunities has greatly increased the migrant population, with settlements expanding westwards toward the Pete CDC camp. Presently, the Malende migrant population consists of people from the grassfields (Northwest and West Provinces), the Beti (Centre Province), and the coastal region (Southwest and Littoral provinces). The settlement pattern is such that migrants from the same ethnic groups with similar cultures settle close to one other. Presently, Malende has seven quarters (wards) named after the ethnic groups to which the first migrants pertained.

2.5.4.2 Ethnicity

Koudandeng's principle ethnic group is the Beti, with relatively homogenous sub-groupings that strive to maintain their traditional culture. The 2002-2003 household census identified three ethnic groups in Koudandeng (Etone: 98%, Ewondo 1%, and Sanaga of the Mbam et Inoubou administrative Division 1%), all of which hail from the Centre Province. The Etone, Ewondo Manguissa and Bene tribes make up the Beti ethnic group, so that 99% of Koudandeng people are Beti. The people of Koudandeng belong to the Nkolfepe lineage of the Esselle Clan of the Eton tribe. Other lineages of the Esselle Clan include Endinding, Bakassa, Mendoum, Menyahda, and Mvog Kani.

Malende, on the contrary, has much greater ethnic diversity with native (indigenous) people in a minority, who mingle with immigrants from other regions of Cameroon. The 2003 household census reported the following ethnic diversity for Malende: i) native Balong/Mbo speakers (13%), ii) West Province origins (6.5%), Northwest Province origins (62%), Southwest Province (excluding the natives) origins (26.1%), Centre Province origins (4.3%), and Littoral Province origins (1.1%). In relation to the sample population studied (30 households containing 55 cassava farmers), households from the following 10 ethnic groups were interviewed: i) Southwest Province (natives: 14.5%, Bayangi: 1.8%, Bakossi: 3.7%, Bangwa: 20%, and Ndian: 1.8%); ii) Northwest Province (Menemo and Moghamo: 32.8%, Tikari: 5.4%, Aghem, Beba and Modele: 9.1%); iii) Littoral Province (Albo: 5.4%); and iv) West Province (Bameleke: 5.4%).

2.5.4.3 Marriage and households

Within the Beti ethnic group, women and men from the same clan cannot marry because they are considered as blood relations. Kin and blood relations are complex and are traced to the fourth generation. This stems from the belief that procreation ensures the protection of family property, especially land, and therefore it is traditionally acceptable for a man to have children by more than one woman who may not necessarily be his legal wife. For example, a deceased man's brother will take his sister-in-law as a 'wife' especially if her husband dies without a male heir, so as to ensure the continuity of kin and protection of family property (land and tree crops). An impotent man would choose another responsible man in the village to have children with his wife to ensure the protection of his property when he dies. It is traditionally acceptable for a man to have sexual relations with his wife's younger sisters, and clearly polygamy is culturally acceptable. This complex web and fabric of procreation favours a high rate of infidelity, which leads to complex kin relations.

Intermarriages between clans are possible, while intermarriage between lineages of the same clan is taboo. Most married women in Koudandeng come from clans other than the Esselle, or from lineages that are not of the Esselle clan. Guyer (1977) confirmed this in her study of Beti women's cultivation systems in Lekie Division, where she states that all of the women of Nkometou and Nkolfeb come from different neighbouring clans. People from different clans and other foreigners are considered as 'slaves' and are commonly called "beloua", so that women who marry into the Esselle clan are foreigners or "beloua".

Two main types of marriage were identified in Koudandeng: contractual (traditional, civil registration, and church), and concubinage, which is the non-contractual form of marriage. Concubinage in this research refers to a couple that is living together without any formal (contractual) arrangements or to married persons who are maintaining extra-marital relationships, especially in the case of men whose infidelity is traditionally accepted. There appears to be a division between the younger generation (<50 years old), who are more engaged in concubinage and sometimes registered civil marriages, and the older generation, where traditional contractual or church marriages are more common (Papa Bonavanture, 79 years, Eloundou, 43 years, Ayissi, 40 years, Paul, 43 years). In the pre-colonial era, traditional marriages predominated. Traditional and church weddings were fashionable up until some fifty years ago, since missionaries encouraged traditional marriages between couples as a precondition for church weddings. The post-colonial period saw the introduction of registered civil marriages and, today, such marriages and concubinage are the most common. Engaging in traditional or church weddings involves high expenditures, which most young men avoid by opting for concubinage and, to a lesser extent, civil marriage.

Traditional marriage entails the payment of a bride price. While this bride price is considered as a source of riches for the bride's family, the family of the bridegroom sees it as an enormous expense. Discussions with five men and women indicated that the bride price consists of food items, drinks, clothing, and household utensils, and varies according to the family. Food items may include, amongst others: a 100 kg bag of groundnuts, a 50 litre container of palm oil, a 100 kg bag of smoked fish, a 100 kg bag of egusi, a 100 kg bag of onions, five or six pigs weighing at least 150 kg each (one for the bride's kin, two for the bride's mother, one or two for the bride's father and one for the bride's sisters). Cassava is not used as a bride price payment, but it can serve as a source of income for the purchase of the items requested. Drinks include so many crates of beer, many 20 litre jugs of palm wine, containers of red wine and hot drinks (meungwalla, Johnny Walker, schnapps, etc.). Clothing includes many metres of different kinds of cloth (wrap) for the bride's mother and sisters, a suit for the bride's father, and blankets are also provided. Pots and mills or grinding machines for spices and egusi constitute the kitchen utensils requested. In the past, all of the items requested were given to the bride's kin. Nowadays, the high costs of these items means that most young men do not seek a traditional marriage and others chose the items according to their means. The list of bride price items is signed in duplicate and kept by both families because these items must be returned to the giver in the case of divorce. In the pre-colonial era, when people could neither read nor write, the list was memorised by different persons who served as witnesses. Because of this, women were obliged to remain in their marital homes despite being poorly treated by their husbands:

> Our parents were very strict with their married daughters and will not accept divorce. How will they pay back the bride price that was so heavy? We the girls were forced to stay in marriage and bear all the torture given by our husbands. The education of girls was total submission. Our daughters of today claim that the issue of divorce is their personal concern and they are the ones suffering and not their parents and so they have a right to divorce when things are not moving on well (Marie Claire, 45 year old woman).

> If the divorced woman is capable, she can reimburse the bride price, or if she remarries, then her new husband pays back the bride price given by the former husband (this was most common in the days of our parents)...I did not give all the bride price items that were requested of me. I just gave some money and so, now that I am di-

> vorced, I have not requested any reimbursement. We have children and I think that it is foolish of me to request reimbursement of the money that I paid to my ex-wife's family (Eloundou, 43 year old man).

Today, women of the younger generation do not consider the return of the bride price to be a hindrance to divorce, since issues can be settled through the court. According to Therèse (52 year old woman), in the case of divorce, younger women also request compensation for joint property investments, and this often ends up in court.

The traditional marriage ceremony is considered to be a very important life event that is treated with the honour that it deserves. The bride price items are exposed to the community for appreciation, which brings prestige to the bride and groom's families. Drinking, dining, and dancing accompany the ceremony. A delicacy consisting of a large, long baton (cassava paste wrapped in wild plant leaves) and groundnut pudding is exchanged between the two families.

Men today consider that marrying in the church is a form of enslavement or control, which hinders them from continuing with their infidelity as well as mal-treating their wives. According to Papa Bonavanture (79 year old man), Christianity reduced wife abuse. Christian men who abused their wives (beating, infidelity, paternal irresponsibility) were punished and sometimes beaten up by the Catholic missionaries. This kept most men from going to church. Today, such men are fined and sometimes their abuse is exposed to other members of the congregation, which further scares them away from the church. According to Eloundou (42 year old male), the church respects women's rights by refusing to accept polygamy and so most men do not want to contract Christian marriage:

> When a woman has put on the wedding ring, it gives her much power and confirms her position within her marital home, her affine kin and the society. It is a sign of honour for a woman and security for her access to her husband's property, especially if this woman becomes a widow and has young children. Most often widows who are not married in church or civil status find their husband's property is seized by her in-laws. I am not married in church and do not wish to in future (Eloundou, 43 year old male).

Women, on the contrary, prefer contractual marriages for reasons of security: contractual marriages provide for property ownership upon widowhood and give women greater respect and more voice among affine kin and in the society at large, as well as some degree of control over their husbands' behaviour (irresponsibility toward children and wife, infidelity, wife beating, drunkenness, etc). Women whose relations are not contractual often say that they are 'not married' even though they may have children with their men. Such women feel insecure in marriage. Divorce can easily occur since there is no official bond between the two affine families. As such, most women become submissive and subject themselves to rendering services to the man and his kin for fear of divorce. Formal forms of marriage, especially traditional and church marriages, are sometimes contracted even when the couples are old, since this brings prestige to the couples involved.

Two main types of matrimonial relationships are intertwined in these forms of marriage: monogamy and polygamy. A traditional marriage is either monogamous or polygamous, whereas church weddings are strictly monogamous. Civil marriage allows for monogamy, polygamy, and monogamy according to the tribe's customary relations (e.g. providing the opportunity for men to later engage in polygamous or extra-marital relationships). Traditionally, women and men were socialised to accept polygamy, traditionally the main form of matrimony. The influence of Christianity and the rising standard of living and HIV/AIDS prevalence have all favoured the prevalence of monogamy over polygamy.

In relation to women's property rights, women who are engaged in contractual relations have usufruct rights to their husband's property even upon widowhood, whereas women who are not involved in contractual marriages have usufruct right to land for farming and to other property, but they may lose these rights upon the death of their husbands depending upon the decisions of the affine kin. Usufruct rights to land refer to the rights to use something (e.g. farm the land), but not to sell or cede it. Widows who are not contractually married for more than ten years and who have children by their deceased husbands are given usufruct rights to their late husbands' property. Those who do not have children by their deceased spouses and who are not willing to remarry are attributed usufruct rights to part of their deceased husbands' property. Such decisions about property disposal were formerly taken in family meetings, but now they also involve signing of a legal document or obtaining a court declaration. However, some widows are deprived of their rights, especially those who are not on good terms with their affine kin. Such women face confrontations with their deceased husbands' kin, who demand to see marriage certificates. However, in some families, due to the shortage of land, young men seize land from widows (with or without children) while requesting that a marriage certificate be presented as proof of their legal claim to their husband's land. This was the case with Marie Therese, who now depends on land ceded by friends to grow her food crops since her deceased husband's brothers took all of his land from her. A widow who remarries loses her usufruct right to her deceased husband's property as well as the right to the children she had by her late husband. It is culturally unacceptable for a widow who remarries to transfer her deceased husband's property and children to her new husband. Irrespective of the circumstance, widows and other women have no right to hand over their husbands' land and other property to other persons. If they must lend some of their land to other women for food crop production, this should be done with the prior agreement of either their husband or husbands' kin.

Divorced women who were involved in contractual relationships have no right to any property even if the couple invested jointly or had children in common. Discussions with five women and men indicated that, in the case of divorce, the woman leaves behind all property that she and her husband acquired during their marriage. She can sell any crops in her fields and take the money, or she can leave the crops for her children, if she has any, who remain with her former husband. She leaves behind all her kitchen utensils and equipment for her children to use. Women say that they come into marriage with nothing and so they should leave with nothing except their personal belongings. Men say that women do not own land but have the right to use family land during their marriage, but they have no claim to ownership upon divorce.

Traditionally, among the Beti in Koudandeng, residence is patrilocal: women move from their natal villages to live with their husbands and their husbands' kin. Results of the 2002-2003 household census revealed that there are various types of households: monogamous (64.6%), polygamous (11%), female headed (23.3%) and, with the rise of HIV-AIDs, child headed (1.2%). Referring only to headship, dual headed households predominate (76.7%), followed by female headed (22.1%), and child headed (1.2%). The proportion of child headed households is low because orphans are often taken into the households of their deceased parents' kin. Generally, nuclear families are rare, whereas extended households are the norm. It is common practice to find the elderly and their married children and grandchildren living together. One also finds households where divorced women are living with their brothers or parents. About 90% of the female household heads are widows (78.4% from monogamous relationships, 11.8% from polygamous relationships) and about a tenth is divorced. *De facto* female household heads (where women are in marital relationships but their husbands are generally absent) were not found because of the ease of access and short distance between Koudandeng and Obala (15 km) and Yaounde (30 km), which facilitates men's movement between these areas: men who work in Obala and Yaounde can return home each day, which is contrary to some rural areas where especially male workers temporarily migrate to work in urban and semi-urban areas and only visit their wives and children periodically.

Thus, households are generally large, with an average of 10 members and an average of five economic dependents per household. However, a few households are small, with an average of four members, especially those of younger couples. Angèle (45 year old woman) reported that, in their belief system, children constitute riches for a household and so couples should give birth to as many children as possible, so as to allow God to take away those that He wishes, and to allow for those who will become fools or idiots in life and those who will succeed. As such, women who give birth to many children are admired.

As in Koudandeng, in Malende, both contractual and non-contractual forms of marriages exist. Malende's ethnic diversity made it difficult to identify marriage trends over time. In a discussion with the Chief in 1997, he said that church and traditional marriages have become rare compared to the early migration and settlement period (pre-1949). The present high standards of living and the erosion of traditional norms and values have led to a shift away from church marriages to the advantage of concubinage and, to a lesser extent, civil marriage. In most cases, those who claim to have traditional marriages do not fulfil all the necessary requirements, such as payment of bride price. All of the four types of marriage arrangements identified in Koudandeng are also those which exist in Malende, and the traditions and trends appear to be similar for both villages.

Also as in Koudandeng, patrilocality predominates in Malende. Household types are varied due to ethnic diversity. Results of the 2003 household census show that 6.5% of Malende's population is single and, of the 92.5% that are married, 55.4% are in monogamous relationships, 23.9% are widowed, 8.7% are in polygamous relationships, and 2.2% are living in concubinage. Interviews with five elderly persons for a previous study (Nchang Ntumngia, 1997) indicated that polygamy, which was common in the past (especially among the migrants from the grassfields and those of Bangwa origin) has greatly reduced due to the influence of Christianity and a rising standard of living. Despite the HIV/AIDS pandemic, it is still common for men to keep various mistresses, which results in many unstable homes, teenage pregnancies, and many female headed households in Malende. In relation to household headship, female headed (including *de facto* headship) households constitute 30.4% of households in Malende, while 69.6% are dual headed. Child headed households were not found because of the fact that older relatives of migrants come to live with them and, in case of death, young children are either taken back to the village of origin or the relatives assume responsibility for orphans. Even though nuclear families are relatively rare, there are more in Malende than in Koudandeng because migrants tend not to migrate as extended families.

Some 53.3% of the households studied are extended. Average household sizes are relatively small (five members) compared to those in Koudandeng, and the average number of economic dependents is three, rather than five, per household.

2.5.4.4 Gender relations

Due to Malende's ethnic diversity, which makes an understanding of gender relations difficult, gender relations were documented only in the case of ethnically homogeneous Koudandeng. Each culture has defined and acceptable systems of norms and values that moderate the behaviours of men and women and their relationships (gender relations), where adherence to, and endurance of, these norms and values are embedded in belief systems. Gender relations are expressed in societal networks, kinship, and household relations.

In Koudandeng, the need to provide for leadership, security, and subsistence (livelihoods and household food security) have, since the pre-colonial era, been seen as the guiding principles for the definition of customary norms, values, and beliefs in the Etone tribe. Prestige was assigned based on the fulfilment of these principles with the following positions of honour identified in rank order: wrestling, performing traditional rites and rituals, hunting, ensuring subsistence, and chieftaincy. Wrestling and performing traditional rites and rituals are more involved with the societal sphere (involving clans, lineages and families). Women were considered worthless as far as defence and courage were concerned. They could not defend the village nor protect family property. They were fit for care giving and feeding the family and thus were destined to be married off into other kin groups and lineages. They were more useful for creating and maintaining ties between lineages and clans. This explains why women do not have the right to inherit lineage and family property. The criteria for entitlement to inheritance depended on the ability to defend oneself and one's family and property, one's leadership capacity and one's courage. While men, who are assumed to be physically stronger, were responsible for protecting the clan and the household, women were responsible for sustaining procreation. Men's responsibilities were defined in relation to wrestling, hunting, and performing certain traditional rites and rituals that required courage and leadership qualities.

While intertribal wars made wrestling the most prestigious task that measured the relative strength of clans and served as a means of capturing slaves, it was exclusively a male prerogative. In the early days, intertribal wars were common and so wrestling was classified as the most prestigious activity since, through it, one's people were defended against being captured and enslaved. The people of the Esselle clan fought wars with other neighbouring clans such as the Mbokani, Etom, Mendoum, and Mvog Nname. A good wrestler was one who led his people to fight and win, and was therefore highly respected. Renowned wrestlers not only protected the village, but as well protected their kin's property and settled disputes within the village. Wrestling was thus used as means to reinforce family and lineage ties. Wrestling matches were organised by great fighters and village chiefs to demonstrate their strength and acquire slaves and more wives (there are currently two renowned wrestlers in the village). Women competed over such men while parents sought to marry their daughters to them. Women from different clans were given in marriage to reputed wrestlers to maintain social ties and ensure security.

Traditional rites and the related rituals are regulatory mechanisms for maintaining order and peace within clans, lineages, villages and large family groups. Men are assigned responsibility for ancestral and death rites and rituals that concern the general well being of the people. Women, on the contrary, are responsible for fertility rites and rituals (related to child bearing, child development, and agricultural fertility). Women also prepare the food that is eaten during male and female rites and rituals.

Hunting of wild game was considered to involve greater risk and required courage and periodic forays into the forest, so that women, who were expected to take care of the families they procreate, were not allowed to participate. Women were also given out in marriage to great hunters to ensure access for family groups to highly valued game for food such as hyena, chimpanzee, lion, elephants, tigers, porcupines and monkeys.

While hunting and agriculture both provide food, agriculture had lower status since it involved a lot of hard work on a daily basis and the food that was grown by almost every household was not sold in the pre-colonial era. Men and women were involved in agriculture, but there was a sharp gender division of crops and tasks. Traditional men's crops were trees and other perennials whose planting secured ownership over a piece of land. Tree crops (oil palm, plantain) and egusi (*Colocynthis citrullus* lanatus (Thunb.)) were attributed higher value relative to annual food crops (including cassava) that were assigned to women. Egusi was used to pay the bride price and therefore was considered as a male crop (Numbem, 1998). Traditional women's crops were annuals such as groundnuts, maize, cassava, yams, cocoyams, sweet potatoes, and market garden crops such as okra, onions, and tomatoes. This gender division of crops has shifted over the last 10 to 15 year as the prices of men's crops (the traditional export crops) declined, and men have begun to produce whatever food crop that yields income, such as plantains/bananas, maize, groundnuts, okra, onions, tomatoes, and cassava. It is believed that the fertility spirits gave cassava, the main dietary staple, to women, since it is a woman's responsibility and obligation to ensure food for the people that they procreate. Traditionally, men were not allowed to produce cassava.

The gender division of land for agriculture was based on the principle of securing men's ownership over land, and therefore men's crop fields occupied larger portions of households' land compared to women's food crop fields. As land is continually inherited and shared among male siblings across generations, farm sizes have decreased. Especially the land that is allocated to women in usufruct has been greatly reduced (Papa Bonavature, 79 years old). Apart from the older cocoa fields that were established near homes, plantain/banana and egusi were established in forest fields as a means to secure ownership over such land and in response to the agroecological needs and potentials of these crops.

Heads of clans, lineages, and families are male, and leadership is acquired rather than ascribed. It is based on one's leadership and management qualities, such as exhibiting good behaviour, having self-respect and respect for others, working hard, and being truthful and obedient. It also requires that a man be a long-term resident and thus master the customs and traditions of the people, and a man must also be brave and have the ability to defend his kin. Leadership is bestowed on men, and women only assist by organising other women. Women's main responsibility within kin groups is linked to procreation: providing food, child bearing and rearing, care giving, and ensuring the purity of the family line (fidelity), whereas men are defined by their physical strength and courage, and their ability to protect their families and other kin, provide shelter for their families, and make decisions within households and kin groups, and ensure the continuity of the lineage. Strict observation of these roles by men, women, and children determines their status as either 'bad' or 'good'. For example, a 'good' woman, wife, or mother is one who is faithful to her husband, works hard and manages many food crop fields (especially groundnut and cassava fields), feeds her family and her husband's kin well, renders services and takes good care of her family and kin, is not idle and does not gossip with other women, is not quarrelsome, is welcoming and accommodating, and accepts her husband's infidelity. She obeys her husband, gives good advice to her daughters and other girls, is married, has children, and is a great fisherwoman.

A good man, husband and father is one who has built a house, established a plantation (cocoa, oil palm, fruit trees, plantain, banana etc), is married and takes good care of his wife and children. Taking care of the family refers to assuming all family financial responsibilities with respect to providing for health care, children's education and clothing, and contributing to household provisions and food, and not beating up his wives. He should also assist his wife and in-laws (wife's parents) in clearing their food crop fields as necessary.

In relation to gender divisions of labour (roles and responsibilities) in agriculture, traditionally in Koudandeng, the gender division of labour in food crop production is such that men implement tasks that are of short duration and require less skill and higher energy expenditure. Women carry out all of the tasks that require more time and skill. Presently, most women carry out all of the tasks that are done by men in addition to their own tasks, including field preparation. Women exclusively process food and sell cassava. Very few male youths also perform all of the tasks involved in food crop production when this is oriented toward the market. Food crop harvesting, processing, and sale, especially of cassava produced in men's fields, is done by their wives who hand over the income to their husbands after having used part of it to buy household provisions. Men sell cassava at farm gate to women processors. Both men and women sell plantains/bananas. Women assist men in cocoa harvesting and drying, but only men sell it.

2.5.4.5 Demographics

Apart from household and family size, which were discussed above, age, sex, level of education, and household HIV/AIDS status are other demographic variables that are important for this research. According to the 2006 Population Census, the total population of Obala, to which Koudandeng belongs, was around 30,000, whereas that of Muyuka, to which Malende belongs, was around 31,000. In both areas, the population density was about 37 persons per square kilometre and the sex ratio was nearly equal (100 women to 99 men). Adult men and women constituted about three-fifths of the total population. The 68 households (34 in each village) studied represent 11.3% of the total number of households in Malende (300) and 13.7% of the total number of households in Koudandeng. The total population of Malende is about 7000 inhabitants (SDDA Muyuka, Per. Comm.) while that of Koudandeng is about 6000 (Village Reagent, Per. Comm.).

In an average Koudandeng household with 10 members, three are adult men, two are adult women, and five are youths and children. In an average Malende household with five members, three are youths and children and there is one adult male and one adult female (local people define an adult as someone older than 20 since children below this age are highly dependent on their parents for food and income). Of the cassava farmers studied across both villages, 20% (23) are men and 80% (91) are women. While in both villages the majority of cassava producers interviewed were women, in relative terms, Malende men (38% of 55 Malende farmers studied) are more involved in cassava production compared to Koudandeng men (3.4% of 59 Koudandeng farmers studied)

Of the 68 households studied, 27.2% of the adult members are young, 46.5% are of middle age and 26.3% are elderly. Within-age categories varied between the two villages. The age range of the adult members studied lies between 26 and 70 years in the case of Malende, and 23 and 75 years in the case of Koudandeng. The average age of adults is 43.8 years in Malende and 48.7 years in Koudandeng. Some 5.4% and 6.8% of Malende and Koudandeng members, respectively, are 65 or older. The median age in Malende is 42 years where one percent of the farmers are 42 years or younger, whereas in Koudandeng, the median age of farmers is 50 years and 58% of farmers are 50 years old or younger. Farmers in Koudandeng are thus somewhat older than those of in Malende.

The impact of HIV/AIDS prevalence on the agricultural work force in Cameroon cannot be over-emphasised, and Koudandeng and Malende fall within the high HIV/AIDS prevalence zones in Cameroon. According to the 2004 Demographic and Health Survey in Cameroon, HIV/AIDS prevalence in the Centre Province, to which Koudandeng belongs, stood at 4.7% of the total population (women: 6.8%, men: 2.1%), whereas that of the Southwest Province, to which Malende belongs, is eight percent of the total population (women: 11%, men: 5.1%). In relation to the variation in the rate of prevalence, Yaounde and its periurban areas (including Koudandeng) has a prevalence rate of 8.3% (women = 10.7%, men = 6%). An interview with health personnel at the Koudandeng Catholic Health Centre (Centre de Santé Providence de la Mission Catholique de Koudandeng) carried out by the researcher in May 2008 revealed a prevalence rate of 5% for Koudandeng. According to them, in 2007, the prevalence rate among the highly sexually active age group (14-40 years) was 12.3%.

With respect to the population studied, four categories of households were identified: non-affected households (50.9%), affected households (12.2%), afflicted (21.1%), and likely afflicted households (15.8%). Non-afflicted households are those that neither have HIV/AIDS orphans, nor have lost a relation who suffered from HIV/AIDS within the last five years, nor have an HIV/AIDS patient as a member. Affected households are those that have at least one HIV/AIDS orphan. Afflicted households are those that either have HIV/AIDS patients or have lost a household member within the last five years who suffered from HIV/AIDS. Likely afflicted households are those that have members suffering from HIV/AIDS proxy illnesses as defined by the World Health Organization and the Cameroon National Committee for HIV/AIDS Control (CNCC or CNLS its French acronym) (National Institute of Statistics, 2004). Due to the fact that the proportion of patients suffering from proxy-illnesses is not too high (15% in the case of malaria, 35% in the case of tuberculosis) (Pers. Comm. Sister Marie Madaleine, head of the Catholic Health Centre in Koudandeng, May 2008), it was judged inappropriate to classify all off the persons suffering from these illness as HIV/AIDS seropostive. Households whose members suffer from these proxy-illnesses were classified as likely afflicted households. Malende seems to be more highly affected by the HIV/AIDS pandemic compared to Koudandeng. Malende has 38.2% non-affected households, 20% affected, 21.8% afflicted, and 20% likely afflicted and Koudandeng has 62.7% non-affected, 5.1% affected, 20.3% afflicted and 11.9% likely afflicted households.

Although the two villages are located in the tropical forest region of Cameroon, they have different educational systems, with Koudandeng belonging to the Francophone system and Malende belonging to the Anglophone system. This has implications for the number of years of schooling required for completing primary, secondary and high school levels. In the Anglophone system, primary school education takes seven years, secondary school takes five and high school takes two. In the Francophone system, primary education requires six years, secondary education requires four, and three years are required for high school.

In total, three categories of educational status were identified among cassava farmers in Malende: those who have never been to school (14%), those who completed primary school education (54.4%), and those who attended secondary school, learned some type of profession after primary school or attended post secondary education (31.6%). In Koudandeng, 18.6% of the farmers had not been to school and 3.4% have attended post secondary education, while 9.1% of Malende farmers have never been to school and 18.2% attended post secondary education.

2.6 Summary

An understanding of the implications of the promotion of cassava HYVs and the use of fertiliser by the Cameroon Government, AGRA, and international and national research institutions such as IITA and CIAT for the resilience of traditional agroecological systems, food security, livelihoods, varietal knowledge and conservation, and income for farm households requires that specific crops be contextualised in terms of their agroecological, food, social, spiritual, and economic values. Policies have placed greater emphasis on the agroecological and economic dimensions and parameters while neglecting other factors that influence farmers' livelihood decisions. This limited emphasis has led to the general idea that the solution to the problem of African food insecurity (if and when it exists) can be achieved only by developing HYVs and other inputs such as fertilisers, and by increasingly commercialising their production. One important crop and two villages have been selected for this comparative research. It is argued that Malende and Koudandeng represent an adequate empirical basis for examining the relevance of the goals, the validity of the assumptions, and the appropriateness of the modes of implementation of policies pertaining to the Government of Cameroon, AGRA, and the CGIAR institutions. The basis of the comparison is a discussion of their similarities and differences in relation to their access to cassava markets, production and livelihood resources, HYVs and research and extension services, agroecological potential, subsistence or commercial orientation, and degree of adherence to cultural traditions and demographics, including household HIV/AIDS status.

CHAPTER THREE
CONCEPTUAL FRAMEWORK AND METHODS

3.1 Introduction

This chapter presents and discusses the conceptual framework and the methodology used in this dissertation. It begins by defining and discussing the concepts or conceptual frameworks that have guided the elaboration of the research objectives, hypotheses, and the analysis. Then, the methods and methodological protocols that were used to collect the data presented are discussed in the second section.

Three different conceptual frameworks or approaches to three different topical areas were sought and employed to guide the elaboration of research hypothesis that facilitated the collection and analysis of data which was intended to gain greater insights into the implications of the promotion of high yielding cassava varieties and associated technologies by the Alliance for a Green Revolution in Africa (AGRA), the Cameroon Government, and various regional and national research institutions. The three topical areas dealt with in the thesis are: the productivity and resilience of traditional agroecological farming systems; farmer varietal knowledge, preferences, and conservation; and farmers' goals in agricultural production, including but not limited to food security, livelihoods, and income. While the conceptual frameworks and approaches are derived from different academic fields (ecology/agronomy in the case of agroecology and farming systems; ethnobiology/anthropology in the case of farmers' varietal preferences, knowledge, and conservation; and sociology, economics, and anthropology in the case of farmers' production aims, livelihoods, food security, and income), this research endeavour required that all three fields be articulated and that concepts that are generally divorced from each other be brought into one larger, more inclusive framework in order to highlight and understand interrelations between these different problems. This has presented a major challenge for this research and for the researcher, who is not professionally trained in all of these areas.

The first section deals with basic relevant concepts in agroecology and farming systems, and then focuses on traditional polyculture systems, understanding plant-plant interactions in polyculture production, and scientific perceptions of traditional polyculture systems and consequent threats to these systems. The second section discusses ethnobiological approaches and concepts, with an emphasis on cognition, and particularly sets the stage for developing an understanding of cassava varietal knowledge and variation in knowledge among farmers, the perceptions and classification of cassava varieties that exists in farmers' minds, and the relationship between these and behaviour - what farmers actually grow. The third section discusses food security and then brings to bear anthropological insights into food and foodways, as well as biodiversity and dietary diversity and nutrition. More general concepts of livelihood are then discussed, and all are combined to promote a more global understanding of the goals of traditional agriculturalists.

The second half of the chapter deals with the approach, methods, and methodological protocols that were employed in the study. It highlights the design factors, the reasons for carrying out comparative research, and the procedures used to select the study area and sample populations. The data collection and analysis methods as well as the limitations of the application of some of these methods are also discussed.

3.2 Conceptual Framework

3.2.1 Agroecology and Agroecological Systems

Over the past 100 years or so, agricultural research has been driven by the desire to improve the productivity of landholdings, where crop yields are increased through genetic improvements, the use of new agronomic techniques, and of chemical inputs and water. These could be termed 'conventional' agronomic approaches, where agriculture is highly simplified compared to natural ecosystems, as discussed below. Such agronomic approaches do not generally consider the complex biological interactions within agroecosystems. According to Clements and Shrestha (2004), this is a reductionist approach to agriculture, which has led to unintended consequences such as environmental degradation (pollution, soil nutrient loss, detrimental effects of pesticides on non-target organisms) and social problems (disappearance of family farms, loss of the vitality of farming communities). In response to this and, as an alternative, there has been increased recognition of the values associated with farming that is closer or more similar to nature. While the concept of agroecology was first developed in the 1930s, it wasn't until the 1980s that it evolved into a discipline in response to the various economic and societal pressures that conventional agronomic approaches have faced in recent years.[12]

As a discipline, agroecology can be defined as the application of ecological concepts and principles to the design and management of agroecological systems (Ibid.; Gliessman, 2004), although some, such as Francis et al. (2003), expand the definition beyond production practices and immediate environmental impacts at the field and farm level to include social and economic dimensions. The importance of agroecology lies in the fact that ecological approaches offer new dimensions that help meet the challenges of agriculture: agroecology serves as a link between agronomy and ecology, so that the knowledge of natural ecosystems can be integrated into agricultural practices. Altieri (1995) argues that, as a discipline, it provides the basic ecological principles for the study, design, and management of agroecosystems, taking into consideration the interactions between soils, crops, and farmers, and using farmers' knowledge and skills and existing biodiversity to help make agroecosystems more productive and resilient. In it, a crop field is viewed as an ecosystem where the ecological processes that exist in natural ecosystems also occur, such as nutrient cycling, predator/prey interactions, competition, complementarity, and successional changes. The purpose of agroecology is to illuminate the form, dynamics, and function of these relations to permit a manipulation of agroecosystems to produce better with fewer negative impacts (environmental, social) and external inputs, in a more sustainable manner (Ibid.).

Agroecological systems are the result of human induced changes within natural ecosystems for the purpose of establishing agricultural production (Gliessman, 2004).

They are semi-domesticated systems that lie in a continuum between ecosystems that have experienced minimal human intervention and those under maximum human control (Al-

[12] For a more precise history of agroecology, see Gliessman, 1997.

tieri, 1995). The resilience and stability of agroecological systems is varied and not only depends on environmental or biotic factors, but also on social, economic, and cultural factors. The intensity and frequency of human and natural disturbances determine the structure and function of these systems. Economic conditions and human livelihood strategies, alongside environmental, biotic, and varietal constraints, determine the agricultural strategies of those managing these agroecosystems. This implies that agroecological systems vary according to the location and context in which they are established. For instance, while farmers in Europe and the U.S. are most concerned with maximising yields and therefore the profitability of their monoculture systems that are fine-tuned to respond to such needs, traditional subsistence farmers in Africa tailor their polycultural agroecosystems according to labour availability, access to credit and farmland, kinship obligations, and forms of livelihood. Thus, local variations in climate, soils, vegetation, economic relations, and socio-cultural structures largely determine the types of agroecosystems that are managed in a given region, which usually include both commercial and subsistence patterns of food production.

Agroecological systems can be classified in relation to the patterns of crop and livestock association, the production methods used, the intensity of input use and the resulting output, the intended production objective or purpose, and the set of structures and institutions that facilitate farming operations. Grigg (1974), Norman (1979), and Altieri (1995) discuss seven types of agroecological systems that are found in the tropics: i) shifting cultivation systems; ii) semi-permanent rainfed cultivation systems; iii) rainfed cultivation systems; iv) arable irrigation systems; v) perennial crop systems; vi) grazing systems; and vii) systems with regulated ley farming (alternating arable cropping and sown pastures). All of these systems are dynamic in that they change as a result of farmers' responses to variations in their physical, environmental, economic, and socio-cultural conditions. However, this classification appears to exclude agroforestry systems that involve the management of crops together with fruit and other tree crops. Also, some of these systems embody others. For example, rainfed cultivation systems can also be shifting cultivation systems, perennial crop cultivation systems, or semi-rainfed cultivation systems.

3.2.2 Traditional Polyculture Systems

Whether traditional agroecological systems are rainfed, irrigated, shifting, semi-permanent, or permanent systems, the most essential characteristic is that they are either monoculture or polyculture systems. Polyculture refers to the cultivation of two or more crop species in such a way that they interact biologically (Vandermeer, 1989). Polyculture can be practised in various ways: mixed, row, strip, or relay. Polyculture is different from sequential cropping, which refers to growing two or more crops in sequence on the same field in a year. Polyculture agroecological systems consist of a mixture of crops in association in the same field, whereas monoculture involves planting single-species stands in a field. Polyculture agroecological systems are either generally managed traditionally (using human and animal power, with few or no external inputs) or in a highly modernised manner, using heavy machinery in the case of strip intercropping. This research deals with traditional polyculture systems.

While still representing a simplification compared to natural ecosystems, traditional polyculture systems are nonetheless among the most ecologically complex farming systems on the globe. The main feature of traditional polyculture systems is the variation of crop diversity in space and time. Altieri and Nicholls (2004), Ewel (1986), and Soule and Piper (1992) show that traditional tropical farmers' complex polyculture and agroforestry systems mimic the structure and function of natural communities and thus acquire many features of such communities, such as tight nutrient recycling, resistance to pest invasion, and high levels of biodiversity. Gliessman (2004) cites energy flow, nutrient cycling, and population regulating mechanisms and dynamic equilibrium as key emergent properties that occur as farmers continually alter the structure, composition, and function of their polyculture farming systems. The general ecological features of traditional polyculture systems are:

i. Spatial and temporal diversity and continuity that helps to ensure regular and varied production output as well as maintaining biotic relationships that are beneficial;
ii. Optimal use of space and resources where intercropped plants with different growth characteristics, canopies, and root structures facilitate a more efficient use of water, solar radiation, and nutrients;
iii. Nutrient recycling, where relatively closed cycles of nutrients, energy, water, and waste are maintained to sustain or improve soil fertility;
iv. Water management and/or conservation where cropping patterns are adapted to the amount and distribution of rainfall in rainfed areas or, for example, by making raised seed beds in swampy areas; and
v. Control of succession and protection of crops as a measure of coping with the effects of undesirable organisms such as pests and diseases (Altieri, 1995).

Traditional polyculture systems have undergone cultural and biological evolution and generally are considered to make efficient use of natural resources and to be adapted to farmers' local conditions (Altieri, 1995; Francis et al., 2003; Howard et al., 2008). These traditional systems are often small scale and rely on local resources and complex crop arrangements, and do not require the use of external inputs. Netting (1993) found that these systems are reasonably productive and stable, and thus portray a high return per unit of labour and energy.

Traditional polycultural systems represent the interactions among ecological, technological, and socioeconomic and cultural factors (Gliessman, 1985; Hernandez X, 1977 cited in Brush, 2004; Francis et al., 2003) as major driving forces. In managing them, farmers are generally more interested in the total production of, and services rendered by, the farming system, rather than in the productivity of individual crops. Their management has been associated with strategies to promote dietary diversity, income generation, production and stability, risk minimisation, reduced pest and disease incidence, efficient use of labour, intensification of production with limited resources, and maximisation of returns given low levels of technology (Francis et al., 1976; Harwood, 1979a; Altieri, 1995, Diehl and Howard, 2004).

As such, farmers' practices, which were formerly regarded as primitive, have been shown to be knowledge intensive, complex and, very often, sustainable. Sustainable crop yields are obtained through the proper balance of crops, soils, nutrients, sunlight, moisture, and other coexisting organisms (Altieri, 1995). These desirable outcomes have often been cited as advantages of polyculture systems over monoculture systems in terms of:

a. Yield, which is expressed as the land equivalent ration (LER), which compares the amount of land area used in monoculture to produce the same amount of crops with one hectare of polyculture, using the same plant populations (Vandermeer, 1989; Altieri, 1995);
b. Efficient use of resources (land, water, light, nutrients) by plants of different heights, canopies, and nutrient requirements (Altieri, 1995);
c. Nitrogen availability where cereal legume mixtures are present;
d. Pest and disease incidence reduction (Altieri and Letourneau, 1982; Altieri and Liebman, 1986; Vandermeer, 1995);
e. Weed suppression;
f. Insurance against crop failure;
g. Providing effective soil cover and reducing the loss of soil moisture;
h. Ensuring a steady year round supply of food and opportunities for marketing and for improving local diets, thus avoiding malnutrition;
i. Spreading labour costs throughout the cropping season and maximizing returns per unit of labour input, especially during periods of labour shortage;
j. Serving as a medium for farmer experimentation and emotional reflection and expression.

It is argued that crop diversity and polyculture produce or enhance diverse ecological interactions (Vandermeer, 1989, 1995; Holmes and Barett, 1997), making such systems more stable and resilient, and thus more likely to recover when subjected to stress.

3.2.2.1 Plant-plant interactions in polyculture

Within polyculture systems, different crops accommodate, complement, and compete with each other, thus creating a complex, heterogeneous, and dynamic system. Interactions between crops, other living organisms, and the nonliving physical environment are a function of the diversity and therefore of the sustainability of traditional agroecological polyculture systems in terms of their structure, composition, and functions. Some ecological concepts that are used to explain the different types of biological and biochemical interactions that occur in polyculture systems include: competition, allelopathy, facilitation, mutualism, synergy, autoecology, and synecology.

Two crop species or populations in a polyculture system are said to be competitive (interfering) when the interaction between them exerts a negative effect on one species or the other. When either individuals or populations make use of the same or similar critical resources, then the competitive interaction is known as exploitation competition. When one species or plant population interferes with the well being of the other, then the interaction is known as interference competition. Examples include tree crops that shade non-tree crops, reducing sunlight and thus photosynthesis and growth in the non-tree crops, or crops producing allelochemicals that inhibit the growth of the other species or population. In the case of the production of allelochemicals, the nature of interaction is termed allelopathy, which occurs as a result of biochemical interactions among plants (Vandermeer, 1989; Altieri, 1995). Farmers' choice of crop mixtures in their polyculture fields is such that the spatial distribution of crops or populations in their fields does not permit competition between crops at any given period.

In a situation where the interaction between two crop species or plant populations leads to at least one crop or population exerting a positive effect on the other, this is termed facilitation, for example, when legume crops fix nitrogen that is then taken up by cereal crops in a legume-cereal crop mix. When facilitation occurs both ways, then the process is called double facilitation or mutualism. In a legume-root and tuber-cereal association, for example, while legumes provide readily available nitrogen for absorption by the other non-nitrogen fixing crops and also ground cover, which prevents the loss of soil moisture and nutrient erosion through leaching, root crops (such as cassava) whose roots extend beyond legume's root zone and form extensive associations with mycorrhizae fungi, assist legumes in the uptake of phosphorus by expanding soil volume and recycling nitrogen through its residues for the next season's crops (Fermont, 2007).

Synergy can be referred to as the combined beneficial effects of the interactions between two or more individual crops or populations relative to the beneficial effect of only one crop or population. For example, in a polyculture system, different crops or crop populations exhibit differential susceptibility to diseases (pathogens) and pests, as well as enhance the proliferation, abundance, and efficiency of natural enemies. These combined effects reduce the incidence and spread of pests and diseases in such fields.

Autoecology, or physiological crop ecology, refers to the study of the relation between individual crop organisms and other factors within the immediate environment. It involves an understanding of how each environmental factor in a farming system affects the individual crops that are planted in a field and their variation in time and space. Environmental factors include: light, temperature, moisture, soil, fire, the atmosphere, wind, and other living and non-living organisms. Three factors with major importance for autoecological studies are: i) understanding the nature of crop distributions in fields and where particular crops might grow and produce optimally (niche areas for particular crops); ii) learning how to associate each crop to each factor and make use of the factor to improve farming systems; and iii) understanding the range of tolerance that each crop has for each factor and the optimum level and cropping intensity that leads to the best crop response (Gliessman, 2004). However, in polyculture systems, each environmental factor does not operate in isolation or in a static manner on a crop organism. Individual crops interact with and affect each other and other elements in their immediate environment, which may include other crops, non-crop plants, soil microorganisms, animals, and insects, and the physical environment (light, temperature, soil, moisture). Such interactions lead to the emergence of characteristics that are visible only when the crop environment is studied as an environmental complex.

Crops and plant populations also interact with biotic factors in the environmental complex. These complex biological interactions between crops and other living organisms are known as synecology. The main focus of synecology is on studying individual crop populations of the same species or variety, where the primary concern is with rates of growth, development, and carrying capacity of the environment (planting density, etc.).

3.2.2.2 Perceptions of traditional polyculture systems and threats

Despite the resilient nature of farmers' traditional polyculture systems, they have often been considered by outsiders (researchers, extensionists, policy makers) to be low yielding and environmentally unsustainable. Low yields are emphasised in an agricultural commodity focus that promotes mainly economic sustainability and that seeks to maximise yields through the use of high yielding varieties and the external inputs such as fossil fuels, chemical fertilisers, pesticides (Odum and Barrett, 2004), herbicides, and water that these varieties require in order to achieve their potential yield increases. The agricultural commodity focus emphasises the maximisation of net returns per unit of land or labour. Supposed low yields and environmental unsustainability in traditional polycultural systems have been especially attributed to continuous nutrient extraction through harvesting of biomass, lack of nutrient replenishment through fertiliser use, and reduced fallow periods. It is also argued that they are inherently low in plant nutrients due to the weathering of ancient granite rocks and a low nutrient natural resource base (Bationo et al., 2006[13]; AGRA, 2006).[14] The solution to this is presented mainly in the form of a blanket recommendation for increased fertiliser use and use of improved high-yielding crop varieties, which usually translates into the transformation of polyculture and agroforestry systems to monoculture systems, often accompanied by mechanisation.

This chapter questions the validity of such assumptions in the study areas. Apart from this, the negative ecological impacts of mechanised monocultures in the tropics have been amply documented in the literature (Kowalski and Visser, 1979; Altieri and Letourneau, 1982; Luna, 1988; Browder, 1989; Andow, 1991; Conway, 1997; Morales et al., 2001; Altieri and Nicholls, 2004; Gliessman, 2004). These authors discuss the deficiencies of such monoculture systems:

i. Reduced options for weed control and higher rates of weed growth, thus requiring higher labour input when hand weeding is employed;
ii. Microclimates are more favourable for the development of diseases. For example, in the case of creeping crops (such as peas) planted in monoculture, the circulation of air is reduced and humidity is increased, thus favouring the spread of nematodes, fungi, and bacteria that cause diseases;
iii. The intensity of plant pathogens is severe;
iv. Nutrient cycles are open thus allowing for waste of resources;
v. Highly dependent on human control and use of external inputs;
vi. High productivity but lower sustainability and stability;
vii. Require higher levels of environmental control and large amounts of external energy to accomplish biological activities;
viii. Inefficient use of environmental inputs such as water, nutrients, and solar radiation;
ix. Greater risks of crop failure;
x. Greater exposure of the soil surface and thus higher levels of soil water evaporation, lower levels of transpiration, lower soil quality, reduced water infiltration and greater susceptibility to soil erosion through wind and water;
xi. Limited access to immobile nutrients such as phosphorus and a lower capture of soil nutrients that are made available through mineralization, especially if the crop's root system cannot exploit greater volumes of soil;
xii. High abundance of herbivorous and arthropod insect pests species and low abundance of predators and parasitoid species that act as natural enemies of insect pests, due in part to the destabilisation of predator-prey and parasitoid-host population dynamics

[13] Bationo et al., 2006 at: http://www.agra-alliance.org/section/work/soils
[14] http://www.agra-alliance.org/section/work/soils

and the large and dense population pure stands that facilitate insects with a narrow host range in locating and remaining upon host plants. This greatly reduces crop production in times of insect pest incidence;

xiii. Lower crop diversity resulting in inadequate diets and nutritional imbalance for producers' households.

These analyses point to the problems related to monoculture systems where it is believed that the natural structural and functional diversity of agroecosystems is reduced, thus destroying ecological resilience and necessitating continuous use of external inputs.

Thus, approaches that seek to maximize the yields of specific crops that are promoted by the Cameroon government, AGRA, and research institutions are likely to sacrifice environmental sustainability (Altieri, 1995; Gliessman, 1997; Kimbrell, 2002). The emphasis on high yielding varieties, with the subsequent reduction in crop diversity, and on the use of synthetic fertilisers, pesticides, and herbicides, and therefore a shift toward monoculture and toward production for markets, constitute some of the forces that alter these agroecological relations in ways that tends to undermine human well-being, environmental integrity, and biodiversity. The use of inputs and machinery have shifted agroecological systems to a state far removed from natural ecosystems (Clements and Shrestha, 2004), thus creating an imbalance in the biological functioning of these systems, which reduces their resilience. Alterations to these ecological systems either in term of their structure, composition, or function, leads to an imbalance with negative consequences.

Over time, many subsistence farmers have modified and adapted their polyculture farming systems to meet their diverse ecological, economic, social, and cultural needs and interests. As such, economic, social, and ecological variables in traditional polyculture systems are interdependent and should be viewed as a whole in research and development. Compromising one factor creates problems for the system since the other factors become vulnerable, and can lead these systems into an unstable state (Howard et al., 2008). The accumulated knowledge, co-evolved cultural institutions, and ecosystem services upon which these traditional agroecosystems depend become stressed when subjected to major external change drivers. Some of these threats may include: loss of biodiversity, changes in the range of species, increased microenvironment and climatic variability and shocks such as water stress, increasing energy costs and scarcity of energy resources, increasing tensions over resource access and environmental problems, and general economic and social instability and decreasing welfare (Ibid.). All can threaten food security and may also increase the level of poverty among the managers of these traditional polyculture systems, as well as lead to ecological instability and even collapse. This discussion permits the development of hypotheses that permit an examination of the implications of the Cameroon Government, CIAT's, and AGRA's promotion of shifts in traditional farming systems for cassava farmers.

3.2.3 Ethnobiology, Ethnoscience, and Cultural Domain Analysis

3.2.3.1 Ethnobiology

The field of ethnobiology (and its sub-fields, such as ethnobotany, ethnozoology, and ethnoecology) is a fairly new scientific discipline that can be defined as the study of how humans perceive and organise knowledge about the natural world, as well as their practices and beliefs (Cotton, 1996; Martin, 1995; Gragson and Blount, 1999; Nazarea, 1999). According to Ellen (2006), ethnobiology is defined as the study of how people of all, and of any, cultural tradition, interpret, conceptualise, represent, cope with, utilise, and generally manage their knowledge of those domains of environmental experience which encompass living organisms, and whose scientific study is demarcated as botany, zoology, and ecology. It is about people's own concepts of people-nature relations, and involves an understanding of peoples' perceptions of the natural world and their practices and beliefs. As discussed below, the appropriate ethnoscience term that is used in this dissertation to understand farmers' perceptions of the natural world and their practices and beliefs is 'ethnobiology'. The emphasis here is on *cognitive ethnobiology* and the focus is on local knowledge, perceptions, and understandings of crop species and varieties and their relations with the environment and culture.

The importance of ethnobiology lies in the fact that it permits the use of methods that capture what is inside the informant's head (modes of thought) to obtain what is called cognitive salience or valid models of cultural knowledge (Crick, 1982) about a cultural domain. It seeks to go beyond the local to compare knowledge between different human populations and its consequences for a specific domain, and to establish generalisations that are valid at the regional, global, and species level (Ellen, 2006). It is analytic and descriptive, and is defined in part by its methods, which are used in various types of studies, and it seeks to produce knowledge of the relationship between categories and behaviour and between culture and social action (Ibid.). In this research, an ethnobiological approach and methods are used to study how farmers perceive and classify cassava varieties in relation to their culture and their praxis (what they grow).

Understanding how farmers relate with their cassava varieties is primordial to analysing (a) the implications of policies, goals, and research orientations that promote HYVs, (b) the performance of agroecological systems, (c) crop varietal conservation and diversity, and (d) food security, livelihoods, and income. This involves researching folk or local understandings of the different varieties that farmers manage (including HYVs) from an 'emic' (insider's) perspective rather than from an 'etic' (outsider's) perspective. This type of research is referred to as ethnography, and the use of a set of conceptual methods that help systematise the emic description of life worlds using techniques of semantic analysis is called ethnoscience, cognitive anthropology (Amundson, 1982; Morey and Luthans, 1984; Sturtevant, 2009), or ethnographic semantics (Morey and Luthans, 1984). Ethnoscience, or cognitive anthropology, therefore refer to the set of methods that permit the study of folk conceptual and classification systems. They involve articulating the beliefs about the world and culture that are used by local people.

Studying local understandings from an emic perspective allows a focus on within-culture similarities and variations that reveals values, norms, and beliefs, whereas an etic perspective focuses on similarities and variations across cultures that largely obfuscate these (Large, 2002). HYVs are promoted for their universal qualities and similarities (in yield, quality, pest and disease resistance, environmental suitability, as a source of food and income), whereas traditional African farmers evaluate their varieties in reference to local values (cultural heritage and identity, agroecological requirements and yield, worldviews, food security and foodways, medicinal values, gift giving and ritual values, and possibly income). It is the contrast between these 'etic' and 'emic' perspectives and their universalistic and particularistic values and understandings that creates the tension between the formal promotion of

HYVs and farmers' acceptance of the varieties, which some scientists have attempted to avoid through different forms of participatory plant breeding.

3.2.3.2 Ethnoscience, cognitive anthropology, and human knowledge

Ethnobiology is in turn one of the domains of 'ethnoscience'. Cognitive anthropology arose in the 1950s out of the ethnosciences as a sub-field, where the importance of both ethnoscience and cognitive anthropology lies in the fact that these suggest the existence of more than a utilitarian relationship between people and nature and forms of knowledge produced by 'common sense,' which rests on a mental outlook that is common to all humanity (Atran, 1986 cited in Sanga and Ortalli, 2003). They provide greater insights into the meaning of particular things and events as seen by participants of a culture themselves (Evaneshko and Kay, 1982). Cognitive anthropology particularly focuses on the use of language, on linguistics, and meaningful cultural categories: it "investigates cultural knowledge, knowledge which is embedded in words, stories, and in artefacts, and which is learned from and shared with other humans" (d'Andrade, 1995). In large part, it is defined by its methods, and in this dissertation, cognitive anthropological methods are used to provide an understanding of the meaning of different cassava varieties for farmers and to relate this with the varieties actually grown that have an impact on their livelihoods, income, food security, and the management of their agroecological systems and agrobiodiversity.

Even though the term 'ethnoscience' is critiqued because it suggests that other forms of ethnography are not science whereas folk classifications and folk taxonomies (or what is called native thought forms) are science (Amundson, 1982; Sturtevant, 2009), it is used in this research to emphasise the fact that native or farmers' cognition is genuinely scientific. Ethnoscience is used as a general ethnographic approach that may be employed to understand peoples' perceptions of their natural world and their practices and beliefs. With reference to the plant and animal world, the ethnoscience term used is 'ethnobiology'. The emphasis here is on cognitive ethnobiology, which focuses on local knowledge, perceptions, and understandings of crop species and their relations with the environment.

The term 'ethno' refers to the system of knowledge and cognition that is typical of a given culture, while 'science' means classification, or the necessity to aggregate things into classes of complete general characteristics of living things (Sturtevant, 2009). Howard et al. (2008), citing Anderson (2005), argue that science is a system that is meant to represent the world accurately and empirically, which involves many black box variables (theories and not empirical certainties) that are hypothesised and subjected to examination, and that often turn out to be wrong. Sturtevant (2009) holds that the notion of ethnoscience presupposes that there is no division between indigenous/local knowledge and the science of nature, or what is termed Western natural history. However, the notion of ethnoscience clearly suggests the existence of a difference between indigenous/local/traditional knowledge and modern science. Ellen (2004) explains that the sharp dichotomy that scientists claim exists between science and traditional technical knowledge arises from the general human cognitive tendency to simplify the processes by which the world is understood, which is reinforced by the socially driven need to maintain boundaries around scientists' practices.

Knowledge in this dissertation refers to the way in which farmers categorise, code, process and attribute meaning to their experiences in cassava cultivation (Nchang Ntumngia, 1997), which is intertwined with their traditional belief systems. Due to the fact that knowledge is dynamic, has many sources, is continually exchanged, and new knowledge (ideas) are adopted, tested, adapted, and either rejected or hybridised to constitute new ideas or knowledge, the use of the terms 'local' knowledge, 'indigenous' knowledge, and 'traditional' knowledge may seem inappropriate. However, these concepts are all similar and are appropriate in this dissertation because they are used to mean knowledge that is not derived exclusively from formal education, but that is culturally and ecologically contextualised (embedded in systems of meanings and specific ecological contexts), encoded in language and symbols, and transmitted across generations through various means (oral, demonstrations, learning-by-doing) other than texts (Howard et al., 2008). It is accumulated through trial and error, experimentation, learning-by-doing, imitation, and instruction, and it is hardly the product of an individual, although and at times rapid adaptation to changing circumstances is required that relies on individual innovation (Richerson and Boyd, 2005). Traditional ethnobiological knowledge refers to the diverse linguistic terms, symbols and meanings that facilitate an understanding of the plant and animal world within different cultures and ecological systems. In this dissertation, traditional or local knowledge therefore refers to the linguistic terms, symbols, and systems of meanings that Malende and Koudandeng farmers attribute to the different cassava varieties that they manage.

3.2.3.3 Cultural domain analysis

Within the ethnobiological and cognitive anthropological approach employed in this dissertation, the focus is on the analysis of cassava as a cultural domain. A cultural domain is a body of knowledge that identifies and interprets a class of phenomena that are assumed to share certain properties and that are of a distinct and a general type (Hirschfeld and Gelman, 1994), where a *domain* functions as a stable response to a set of recurring and complex problems that organisms face. Such a response involves difficult-to-access perceptual, encoding, retrieval, and inferential processes that are dedicated to the solutions sought. Following this, a *cultural domain* is one that is contextualised within cultures or is culture-specific. Borgatti (1994) defines a cultural domain as a set of items, which are, according to informants, of the same kind. However, the attributes that people use to distinguish items in a domain are generally unconscious, much as, for example, the use of grammar is unconscious, and thus specific methods are required to uncover domains and their attributes. A cultural domain functions as:

i. A guide to partitioning the world where phenomena belonging to a simple general kind are identified conceptually;
ii. Explanatory frames where domain competence systematically links kinds to restricted classes of properties. For example, a cognitive domain is a class of items that share among themselves, but not with other kinds, a number of properties;
iii. A distinct way of acquiring knowledge through the identification of specific patterns of attributes;
iv. A reflection of specific relations between the world and peoples' knowledge of it;
v. A product of a distinct research orientation (Ibid.: 3-7).

The concept of cultural domain stems from the prime notion that human beings are conferred with a general set of reasoning abilities that they bring to bear on any cognitive task, irrespective of its specific content (Hirschfeld and Gelman, 1994). Reasoning has to do with specific types of information: people do not know what they know in a domain neutral manner. As such, much of peoples' knowledge is domain bounded, and ethnobiology is concerned with cognitive domains.

The importance of using a cultural domain perspective stems from the complexity and variability of worldviews about items or phenomena whose interpretations are sometimes beyond 'scientific' understanding, and are understood as common sense. For example, Borgatti (1994) notes that the notion of 'tree' may be central to our understanding of the plant world, but it is not a concept in modern scientific biological classification systems. However, the notion 'tree' has conceptual meaning and therefore requires the use of a domain perspective if this meaning is to be understood for different groups of people. Examples of domains include: physical entities and processes, substances, living kinds, numbers, social types, artefacts, mental states, and supernatural phenomena. It is argued that knowing more about other traditions is useful in informing one's own interests and the interests of others. Understanding how people come to have the wealth of knowledge about items is central to the domain perspective.

Cultural domain analysis is the use of a set of coherent methods to map the structure of a cultural domain or a set of items that are of a kind with similar properties but that differ from other sets of items. Its goal is the scientific study of culture from an emic perspective. Its importance is that it provides a framework for conceptualising cultural domains by fitting together the different data collection methods and analytic techniques in a systematic way. Drawing upon the methods applied in ethnoscience (cognitive anthropology) and marketing research, cultural domain analysis consists of various methods for data collection: freelisting, triads testing, pile sorting pair-wise comparison, rating, and ranking; and for data analysis it employs factor analysis, unidimensional and multidimensional scaling, quadratic assessment product (QAP), consensus analysis, correspondence analysis, network analysis, property fitting regression (PRoFIT), proximities analysis, and cluster analysis. The techniques that are used in this dissertation are: freelisting, triads testing, consensus analysis, proximities analysis, multidimensional scaling, cluster analysis, and property fitting regression (ProFIT). The principles of each method are discussed in detail in section 3.3.5.6.

Cultural domain analysis involves measuring the attributes of items (monadic data) and of pairs of items (dyadic data), with the purpose of discovering *the attributes that people unconsciously use to distinguish items in a domain*. The basic assumption in cultural domain analysis is that items have attributes, which are either categorical (e.g. colour, shape) or quantitative (seen as a continuum along which each item is positioned). In doing cultural domain analysis, the areas of interests are:

i. Measuring relations among those who are being researched, items, and attributes. The set of data corresponding to any one entity is called a profile;
ii. Dimensions or modes of the data. Dimensions of interest are called 'variables', whereas those that shed light on the primary interests are termed 'cases'. Dimensions are used to discover underlying properties of the object under study. Different dimensions of a data matrix are considered variables at different times depending on the analytic task at hand;
iii. Patterns of distribution of values or attributes that characterise the object being researched. When cases are treated as variables, then the set of scores across all dimen-

sions of the data collected as a 'profile' is used to describe the value associated with any element of a matrix, such as a person, an item, or an attribute.

The basic steps in cultural domain analysis include: i) aggregating and averaging data across cases; ii) examining patterns of association, covariation, correlation, similarity, or differences between variables. These are all summed up as measures of proximity which imply evaluating the extent to which, when one variable has a relatively large value for a given case, the other variable does as well and *vice versa*; iii) examining patterns of agreement and variation between cases; iv) partitioning items into mutually exclusive groups or homogenous groups called clusters; v) computing ratings of items in relation to their attributes; vi) visualising proximities measures across items on a map; and vii) regressing item ratings on plots of the map coordinates of the items in multidimensional space as determined by the multidimensional scaling technique. This technique is called property-fitting regression of PRoFIT.

3.2.3.4 Ethnobiology, participatory plant breeding and crop genetic conservation

Ethnobiological approaches and cultural domain analysis are judged useful in this dissertation because they provide a methodology for systematically discovering farmers' knowledge and perceptions of cassava varieties, and of linking these to their cultivation systems, use values, culture, and beliefs. The methodological protocol draws from methods used in other disciplines and is therefore multidisciplinary, and the methods are applied in a coherent manner which facilitates mapping farmers' mental structure relating to the domain of cassava varieties and relating this to the varieties that farmers actually grow. This differs from the approaches that have and are being used by plant breeders and scientists concerned with crop genetic resource conservation in that such methods are not used systematically. Rocha (2005), for example, argues that most cognitive studies of knowledge only investigate knowledge as an isolated unit within a cultural domain and some seek to link local people's understandings and practices to scientific perspectives, or what can be termed scientific versus indigenous or local knowledge. What is most often missing in the application of these cognitive research methods is methodological coherence that relates how knowledge as a cultural domain is constituted and distributed, how knowledge relates to farmers' perceptions and classification of varieties, and how these may influence conservation (what they grow, do not grow or have never grown and why). For example, most participatory plant breeding and evaluation approaches involve one or more of the following methods: preference ranking of varieties to permit identification of those attributes that farmers consider to be most important (Kizito et al., 2006; Gibson et al., 2008, Paris et al., 2008), farmer ranking of varieties per important attribute (Manu-Aduening et al., 2005), or surveys asking farmers about varietal attributes accompanied by regression analysis against farmer socioeconomic characteristics to determine preferences for and classification of crop varieties (Lacy et al., 2006; Abay et al., 2008). Some attempts to analyse farmers' perceptions of crop varieties evaluate the level of adoption of HYVs (Sall et al., 2000; Edmeades et al., 2008), or use econometric modelling methods such as simultaneous estimation of conservation of crop biodiversity and adoption (Smale and Heisey, 1995; van Dusen et al., 2007; Edmeades et al., 2008). Most often, such methods are applied in isolation and, at best, can provide only a partial understanding of certain factors that influence farmers' conscious decision making. A few studies attempt to empirically link their cognition with behaviour (praxis) (Price, 2001; Lacy et al., 2006).

Farmers' preferences are based on their cultural understandings or knowledge frameworks, practical experience, beliefs, and social identity, which form the unconscious dimensions of varietal selection and which therefore influence the conservation of crop genetic diversity. Crop genetic conservation research is increasingly oriented towards achieving an understanding of the processes and linkages, dynamisms, and practices that are essential to the ways in which biodiversity has long been and continues to be managed in farming systems (Jarvis et al., 2007), and some has begun to incorporate cognitive anthropological methods and insights as a basis for understanding farmers' choices (e.g. Brown and Hodgkin, 2007), including the importance of varietal naming (e.g. Sadiki et al., 2007). However, it is most common that crop use values are seen as utilitarian in an agroecological or economic sense and are based on 'private value' (e.g. Gauchan and Smale, 2007), whereas cultural, social, spiritual, and medicinal values are often neglected even though these may be the most significant in determining crop conservation (e.g. Iskandar and Ellen, 1999). It is supposed that the most important factors leading to domestication and conservation of crop resources are utility and conscious human intention, whereas in fact characteristics that are not related to practical use (e.g. perceptual distinctiveness, achievement of status or prestige) and cognitive factors (e.g. varietal naming), may be the underlying causes of varietal conservation or loss (Shigeta, 1996; Boster, 1984, 1986), where Shigeta (1996: 265), for example, argues that 'Utilitarian selection takes place just after cognitive selection.' The assumed relations between farmers' crop choices and genetic diversity are not often investigated. Brown and Hodgkin (2007) point out that a variety of approaches is needed to determine what traditional knowledge is being maintained and by whom.

The relationship between farmers' knowledge of crop varieties and their behaviour (practices) is an important factor determining the acceptance of new crop varieties such as cassava HYVs. Knowledge varies across farmer socioeconomic categories and this variation is determined not only by their cognition, beliefs, social attitudes, and behavioural norms, but as well the constraints on their behaviour (e.g., land and labour access, social obligations, education). Thus, in one chapter this dissertation explores the relations between cultural cognition and cassava varietal diversity, but it also explores farmer praxis in relation to production, processing, marketing, and consumption of cassava varieties and HYVs and the opportunities and constraints that they confront.

3.2.4 Parameters of Traditional Agricultural Systems

Parameters are those factors that define a system and determine its performance. It is argued in this dissertation that most researchers and development specialists that seek to 'improve' such agricultural systems from outside have only a poor understanding of the parameters of many African traditional agricultural systems. The approach adopted here deals as holistically as possible with these parameters which, it may be argued, are at the same time the goals of traditional agricultural producers and their households with respect to their livelihoods and those of future generations, and the relationships between these and household food security. It questions the assumptions that are made by AGRA about African farmers' production goals and, in so doing, challenges the assumptions underlying policies of the Cameroon Government and of AGRA's initiatives. To more conventional discourses about livelihoods and food security, it adds the concepts of foodways and dietary diversity and their relations with biodiversity.

3.2.4.1 Food security

Food security is a concept that originated in the mid-1970s as a result of international discussions on problems related to the global food situation (Clay, 2002). According to the 1996 World Food Summit and *The State of Food Insecurity 2001*, food security can be defined as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). The following variables have been put forth as being central to the attainment of food security: availability, access, utilisation/consumption (USAID, 1992), and vulnerability (FAO, 2002; Mittal and Sethi, 2009).

Food ***availability*** may be defined as having sufficient quantities of the appropriate and necessary types of food obtained from domestic production, national stocks, and net imports (trade, food aid) that are constantly available to individuals or within their reach. The purpose of ensuring food availability is to sustain a steady expansion of food consumption and to offset fluctuations in production and prices (Ibid.). The issues stressed are volume and stability of food supply. USAID (1992) considered that constraints to food availability are due principally to: i) inappropriate agricultural knowledge, technologies and practices; ii) inappropriate economic policies; iii) inadequate agricultural inputs; iv) lack of foreign exchange; v) non-existent or ineffective private sector; vi) population growth rates that offset increased production or imports; and vii) natural resource, disease, and climatic constraints. AGRA principally considers food security from the perspective of food availability, and then assumes that it is constrained especially by the use of low yielding crop varieties, poor soils and lack of fertiliser use to increase productivity, which it is attempting to address.

Access to food refers to the capability of individuals to purchase or procure food (Mittal and Sethi, 2009). This means that individuals must either produce enough food or have adequate income or other resources to purchase or barter to obtain the foods needed to maintain consumption of an adequate diet or nutrition level (USAID, 1992), where the main emphasis is on having enough income or resources. Some constraints to having access to food include: inadequate economic growth, inadequate training and/or job skills, lack of credit, food losses associated with ineffective and inefficient harvesting, storage, processing, and handling, and inefficient food policies (Ibid.).

Food utilisation/consumption refers to processing and consumption of nutritionally adequate food. This takes into account food preparation, storage, utilisation, food safety, nutritional safety, and dietary balance. Here, the emphasis is on health, sanitation, and nutrition. Established constraints to food utilisation and consumption are considered to include: nutrient loss associated with food preparation, inadequate knowledge and practice of health techniques (nutrition, child care, sanitation), and cultural practices that limit the consumption of certain food types by individuals or groups (Ibid.).

Food vulnerability refers to the vulnerability of the population to food insecurity due to social, political, economic, or physiological factors. Some of the factors that are considered to cause vulnerability to food security include: low income (Mittal and Sethi, 2009), insecure land tenure (Pottier, 1999; Mittal and Sethi, 2009), and the multiple interconnections between food production, commodity markets, and labour (Pottier, 1999).

What the definitions and issues laid out above do not refer to, to any substantive degree, is the fact that, while food is essential for human health and well-being, it is far more than just a source of nutrients: it is a key component of one's culture and is central to one's sense of identity (Koc and Welsh, 2002). Food serves as a medium for passing on culture and traditions to future generations, maintaining family ties, defining relationships, creating a sense of unity within groups through the giving and receiving of care, and demonstrating prestige and social status (Bossard, 1943; Fieldhouse, 1986; Lupton, 1994; Kaplan, 2000; Kittler and Sucher, 2001). Food is a symbol of cultural and religious identity, a centrepiece of rituals and ceremonies of all types, and a symbol of emotional experiences and of moral sentiments (Fieldhouse, 1986). Food practices, in other words, constitute part of a set of customs that make up a culture.

3.2.4.2 Foodways

Foodways is the term used to refer to a group's food choices and preferences, to the symbolic importance of food within a culture, to the methods of food preparation and consumption, number of meals per day, meal times, and size of portions eaten, which constitute part of a consistent cultural pattern in which each custom and practice has a part to play. Thus, understanding farmers' decisions in specific contexts about what to eat or grow must focus not on how they satisfy their households' biological (nutritional) needs, which are generally similar across human populations, but rather on how they respond to, and satisfy, non-biological needs. For example, in Koudandeng, cassava is processed into a product called *ndeng* (Fr.: *baton de manioc*), which symbolises a deity (totem spirit) called *ngomedjap* that is believed to have helped their ancestors to cross the river Sanaga when they migrated from Mbam Division. *Ngomedjap* was a long, two-headed snake, and the baton is processed into that shape, and cassava varieties that are suitable for making baton are highly valued. Koudandeng has a reputation for producing good quality and sizable baton, especially among consumers in the semi-urban and urban markets of Obala, Nkometou, and in the capital of Yaounde.

3.2.4.3 Biodiversity-dietary diversity and nutrition

Throughout human history up until quite recently, traditional diets and foodways have been primarily, and of necessity, based on local species. The relationship between biological diversity, dietary diversity, and nutrition has, however, only recently been highlighted. The concern for the loss of biodiversity due to human influences dates as far back as the 1930s, where biological and ecological erosion have been associated with the rapid expansion of industrial and Green Revolution monoculture agriculture (Shiva, 1996), rapid population growth, the growth in international markets for agricultural commodities (Zimmerer, 1996), the globalisation of food systems and diets (Lang, 1996; Johns and Eyzaguirre, 2006), and the extension of patenting and other intellectual property rights systems to living organisms (Shiva, 1996). The initiatives to halt or reverse this erosion have led to an increasing recognition of the important role that farmers in tropical countries (especially the poorest) play in developing, conserving, and managing agrobiodiversity. It has been recognized that small-scale, diverse food production systems that conserve farmers' diversity of crops are marginalised in agricultural development and research, even when the high response of modern varieties used in industrial agriculture are dependent on the genetic variation of farmers' varieties.

The implications of the loss of local agrobiodiversity for foodways, food security, and nutrition have only begun to be explored. In Malende and Koudandeng, it is argued that dietary diversity, nutritional diversity, and food security are intimately related in that farmers plant a diversity of crops and varieties in their polyculture fields, which are combined in different ways to obtain different traditional diets. The composition of farmers' polyculture fields, which is determined by the choice of companion crop species, is such that the traditional diets obtained provide not only the macronutrients but also the micronutrients that individuals require for growth and maintenance. The genetic diversity presented by traditional cassava-based polyculture fields provides nutritionally rich and functionally healthy foods for farming households and consumers as well. The simplification of production systems implied by the mass dissemination of HYVs and the promotion of monoculture is very likely to lead to a reduction in the crop species and dietary diversity that can be obtained from one field, which will have implications for nutrition diversity and security. The consequences are increased exposure to non-communicable diseases such as heart diseases and diabetes and communicable diseases such as HIV/AIDS. The importance of dietary constituents and the functional properties of many traditional foods in preventing or lowering the risks of chronic diseases such as prostrate cancer, cataracts, diabetes and heart disease, as well as lowering the rates of morbidity and mortality, has been spelt out in the literature (Mares-Perlman et al., 1995; Hasler, 2002; Johns and Eyzaguirre, 2006).

3.2.4.4 Livelihoods

Not only are foodways essential to any comprehensive understanding of the various dimensions of food security at household level, including access, utilisation/consumption, and vulnerability: these must also be contextualised within a livelihoods framework. Livelihoods are commonly defined as the combination of capabilities, assets (material and social resources), and activities required to achieve a living (Chambers and Conway, 1992; Scoones, 1998). However, the emphasis in this definition, like the emphasis in the definition of food security, tends to neglect culture, placing greater emphasis on economic dimensions. Defrece and Poole (2008) have shown that, even though the sustainable livelihoods approach is increasingly viewed in international development discourse and initiatives as a way to increase the effectiveness of development assistance, this approach lacks a crucial dimension, which is the significance of culture, that can also explain why resistance to change is in some circumstances a rational response to development initiatives. Gudeman (1986) argues that the central processes of making a livelihood are culturally modelled. What this means is that people's livelihoods (strategies and options) are determined by their culture, and pushing aside culture in development discourse neglects the crucial binding force, which has implications for the success or failure of development projects.

The non-recognition of the relevance of culture in shaping rural livelihoods often leads to the elaboration of rural development policies that have little impact on, and do little to improve, the socioeconomic conditions of the rural poor (Defrece and Poole, 2008). Often, an understanding of the significant roles played by the traditional farming systems in the construction of ideologies and meaning (and *vice versa* - the significance of ideologies, symbols, and beliefs in the construction of traditional agricultural systems) and their relationship to the complex and diverse livelihood strategies at the grassroots level is insufficient. Such an instance has been researched in the case of the role played by the maize milpa production system in the construction of ideology about identity and masculinity among rural Mayan communities of Mexico (Ibid.). Such a lack of understanding also often leads to a classification of traditional farming systems as backward and inefficient, with concomitant arguments about the need to use high yielding crop varieties (even though these often do not respond well in these systems), the adoption of green revolution type technologies, and intensification of production.

Richards (1989) argued that livelihoods are complex, with multiple and dynamic portfolios of different activities, and are often improvised as part of an on-going performance, where this complex combination is considered as livelihood options and strategies. In this dissertation, it is argued that culture (identity, ideology, values, norms, social practices, and spiritual beliefs) strongly shapes livelihood strategies and options in Malende and Koudandeng. Livelihood options are defined as the different opportunities that are available for households and the strategies are the different combinations of activities and resources that households employ while drawing upon their knowledge, skills, and resources. The different livelihood options are interconnected in that households combine most options. For example, fulfilling social obligations and performing traditional rites and rituals requires the redistribution of food, the use of income obtained either from the sale of food (gathered or produced), other commerce, and salaried employment or transfer payments. When carrying out agricultural activities, households require income obtained from various sources. However, which agricultural activities to carry out, how, and to what end, are embedded as culturally shared models of behaviour. Insisting that these models of behaviour change without achieving an understanding of what these models are and how they serve to provide humans with a sense of identity and well-being risks either the failure of such policies and programmes, or unintended negative consequences of their implementation.

3.2.4.5 Goals of traditional agriculturalists

In turn, in order to understand livelihoods, it is crucial to understand the goals of traditional agriculturalists. For over a century, much literature has argued that the goals of traditional farming households (the ‘peasantry’ or ‘traditional’ or ‘subsistence’ producers) are not to maximise profit or income, but rather to ensure self-sufficiency (e.g. Pulido and Bocco, 2003), and not to maximise short term output, but to ensure security or insurance and minimise risk (Grandin, 1987; Friss-Hansen, 1995). Nevertheless, policy makers often assume that farmers aspire to manage farm ‘businesses’, and therefore their actions are primarily economically oriented and their production objectives are to efficiently allocate resources in order to maximise profit. Friss-Hansen (1995) pointed out, however, that the assumption of profit maximisation excludes consideration of the external relations in which households are involved, which are as much determined by cultural factors as by economic phenomena. Households and individuals have other goals in relation to agriculture and grow food crops for a multiplicity of reasons, including ensuring food availability year-round for their households, earning cash to meet household needs, meeting social obligations, maintaining cultural identity, fulfilling spiritual values, managing labour supply, and dealing with land constraints. Placing emphasis solely on the availability of food and income misses these complex and diverse goals, which may have negative consequences at minimum for food security. The problem of food security is clearly multifaceted, involving a complex of technical, social, cultural, and policy issues. In this dissertation it is argued that the multiple reasons that African farmers have for managing a diversity of crops must be considered as a whole in development policies that are oriented towards enhancing food security in Africa.

3.3 Methods

The research was designed as a comparative, cross-sectional study of Koudandeng and Malende cassava-producing households. Due to resource limitations, information was collected at only one point in time, which prohibits the analysis of longitudinal effects. However, the field research was carried out over a period of several years, allowing the researcher to make qualitative observations over time. The design was comparative (two cassava-producing villages that vary in their production orientation, agroecology, and traditions) so as to obtain the broadest possible overview of the implications of the promotion of HYV cassava varieties and associated technologies by AGRA, the Cameroon Government, and various regional and national research institutions for the productivity and resilience of traditional agroecological farming systems, for biodiversity (farmer varietal knowledge, preferences, and conservation), and for achieving farmers' goals in agricultural production that include, but are not limited to, food security, livelihoods, and dietary and nutritional diversity and security that together determine household welfare..

It is assumed that farmers' responses to technological innovations and to greater involvement in the wider market economy differ according to their social, cultural, economic, agroecological, technical, and commercial contexts. Research had been previously carried out in Malende village in Muyuka Sub-division of the Southwest Province (Nchang Ntumngia, 1997), where cassava production is principally oriented toward the market. To select a village in the cassava belt in the Centre Province that could be compared with Malende, a market survey carried out in order to identify sources of supply of cassava products sold in the capital town of the Centre Province, which has some of Cameroon's largest markets for raw and processed cassava. This resulted in the identification of the village of Koudandeng, which is a major supplier of fresh roots and baton, followed by a reconnaissance survey of the village that was intended to familiarise the researcher and collect necessary socioeconomic data that would facilitate the elaboration of research instruments. The third step was to carry out a census in Malende and Koudandeng in order to identify those households that produce cassava. The next phase focused on the elaboration of research instruments and methods, which were pre-tested and adjusted. To ensure the ability to generalise and the validity of the data, a large sample population was selected and subsets of this sample population were selected for further questioning based on the information obtained in previous data collection sessions using different methods. The last phase was data collection and analysis, which are described in detail in the sections below.

Fieldwork was conducted between 2002 and 2008, with most research concentrated in the period 2006-2008. The survey of the Yaounde and Obala markets was done from February to March 2002, and the reconnaissance survey of Koudandeng was done in November 2002. Between December 2002 and January 2003, the household census was carried out in Koudandeng over a four-week period, and the same exercise lasted four weeks (from mid-January to mid-February 2003) in Malende. Twelve months were spent between 2006 and 2008, collecting data in the two villages, including the following activities: i) translation of the survey instrument into French, and pre-testing, modifying, and administering the questionnaire in Koudandeng over a five month period from mid-November 2008 to mid-May 2007; ii) pre-testing, modifying and administering the survey questionnaire in Malende over the period July 2007 to January 2008; iii) freelisting and triad testing in Malende over a two-week period in February 2008; and iv) freelisting, triad testing, interviews and completion of incomplete survey data in Koudandeng from April to August 2008. The bulk of the work with the more time-consuming instruments such as the surveys was carried out when farmers were less busy, such as during festive periods (mid-November through December to mid-January). As indicated in Chapter 2, field research was carried out in Malende in the Muyuka Sub-division in the Southwest Province, and in Koudandeng in the Obala Sub-division in the Centre Province.

3.3.1 Comparative Research and Study Site Selection

A better understanding of the agroecological, cultural, and economic dynamics of cassava production and commercialisation at micro-level among African smallholders who have been subject to policies and programmes that promote green revolution type production technologies as well as commercialisation of cassava, was necessary to gain insights into the possible impacts that such policies can have for well-being and the sustainability of production in Cameroon specifically, and in cassava-producing regions of Sub-Saharan Africa more generally. It was considered that a comparative analysis of two study sites in Cameroon, which are similar in some respects and different in others, would help to reveal those factors that influence cassava HYV acceptance, and to test hypotheses regarding the viability and desirability of more traditional or more commercial cassava production in terms of household welfare and sustainability of production.

The ideal would be to hold market access, production potential (agroecological conditions and production resource access), and access to and knowledge of cassava HYVs as constant as possible across the study sites; none of these should present a limiting factor for commercialisation of cassava, for yield potentials, or for HYV adoption. In addition, neither village should be fundamentally resource constrained (e.g. access to land, labour, or alternative income sources shouldn't be too restricted), since this might seriously limit households' ability to produce cassava for the market, or to access HYVs and other necessary inputs irrespective of government initiatives to promote such efforts.

The ideal would also be to examine certain differences in order to assess the influence that such differences may have for the degree of market participation, HYV adoption, the viability (sustainability, total production) of farming systems, and household well being. One important factor is the orientation of crop production, understood as the degree to which producing households rely upon the crop principally for own consumption (where only small surpluses are sold), on the one hand, or principally for income generation, on the other. Policies aimed at affecting the production and commercialisation of crops that farming households consume as dietary staples may have greater repercussions for household food security and welfare compared to those crops that are not dietary staples and that are produced mainly or solely for sale. The last factor that is important to take into account in Sub-Saharan African contexts (as well as in other regions of the world where cultural traditions remain very strong) that can potentially influence HYV adoption and the degree of commercial integration is adherence to cultural traditions and norms. While the importance of culture (e.g. belief systems, foodways, gender divisions of labour, social obligations) is discussed throughout this dissertation, one of the most significant of these influences is the degree to which production is oriented toward individual profit maximisation, or toward meeting culturally defined obligations (e.g. gift giving, reciprocity), which may compete with market transactions in the disposal of crop surpluses and influence the degree to which people are motivated or not to produce for the market. The proxy for this in this study is the degree of ethnic/tribal homogeneity or heterogeneity in a village: where ethnic groups are diverse, and no particular tribal or ethnic group can be said to dominate, adherence to tradition is less likely to orient and constrain behaviour. Table 3.1 summaries the comparative selection criteria for Malende and Koudandeng.

Table 3.1 Comparative Selection Criteria: the Two Selected Villages Compared

Criterion	*Koudandeng*	*Malende*
Similar access to cassava markets	Good access to peri-urban and urban cassava markets	Good access to peri-urban and urban cassava markets
Similar agroecological potential for cassava production	Good potential; in 'cassava belt'	Good potential; in 'cassava belt'
Traditional production systems	Aside from certain perennials grown in plantation, all other crops grown in traditional slash-and-burn polyculture fields	Perennials plus some annual crops grown in monoculture in evidence, together with traditional slash-and-burn polyculture fields
Similar access to production resources	Small-scale production but generally not land or cash constrained. Use of own and hired labour.	Small-scale production with some farmers land constrained, but not cash constrained. Use of own and hired labour.
Similar access to cassava HYVs and extension	Access to extension and research outreach are limited but farmers are aware of and can obtain HYVs	Extension and research outreach are consistent and focused
Different orientation of cassava production	Primarily as a staple crop, with surpluses sold	Primarily as a commercial crop
Different degree of adherence to cultural tradition	Homogeneous ethnic composition (long-term native); traditional	Heterogeneous ethnic composition (migrant + native); less traditional

Access to cassava markets was considered to be an important selection criterion in the sense that easy access facilitates the sale of cassava and may influence the acceptance of HYVs depending on demand. Market access thus should not present a limiting factor when testing hypotheses about HYV adoption rates and degree of commercialisation of cassava. As discussed here and in Chapter 2, Malende and Koudandeng are both peri-urban villages where cassava production is influenced by the semi-urban and urban markets of Nkometou, Obala, and Yaounde, in the case of Koudandeng, and by Muyuka, Buea, Muea, Tiko, Limbe, Douala, and the Creeks, in the case of Malende. They therefore both have good access to cassava markets.

The agroecological conditions (production conditions and systems) found in the two villages are also important because these provide insights for testing hypotheses about agroecological suitability and sustainability and the need for fertilisers. Farmers in both villages generally use few or no chemical or mineral fertilisers. The discussions below and in Chapter 4 show that Malende and Koudandeng have good soil and climatic conditions and vegetation that favour cassava production, and both are located in the "cassava belt" of Cameroon as mapped by TSBF–CIAT (2009). Further, production systems in both regions are traditional polyculture systems based on slash and burn fallows, where plantations of perennial crops were introduced for export. It is the traditional polyculture systems based on slash and burn agriculture that are generally considered by AGRA and others to be low yielding and in need of external inputs, including HYVs, fertilisers, and soil improvement measures. In Malende, with the increasing commercialisation of annual crops such as cassava, farmers are incorporating fertilisers into their production systems, and a few farmers are opting for monoculture.

When there is very limited access to production resources, especially land, labour, and credit, the acceptance of an innovation or new technology may be limited since farmers base their decisions on the availability of these resources. For example, as discussed in chapters 4 and 6, traditional agriculturalist's attempt to organise their labour investments in agriculture to permit both leisure time and diversification of activities. They tend to avoid new technology or other innovations that increase the amount of labour inputs required. Koudandeng farmers depend more on own and family labour and, to a lesser extent, on hired labour for agriculture, which is similar to the forms of access to labour in Malende households. Land as a production resource is subject to customary laws and regulations that govern its use. Chapter 2 provides background on the nature of access to land in both villages, which are generally not land constrained, although there are certain categories of farmers, especially women and the landless (those who rent land), where land *is* a limiting factor, which therefore has implications for food security and livelihoods for these categories of households. While Koudandeng is generally not land constrained, some of Malende's migrants face problems with land access. Field sizes are smaller in Koudandeng relative to Malende. Furthermore, what people do with the land resources at their disposal can influence the acceptability of an innovation. The availability of credit determines the amount of investment in agriculture for a farm household, especially in terms of access to inputs and land and labour resources. Limited availability of financial capital implies that households must make trade-offs between livelihood activities that require income and labour investments. Malende and Koudandeng households are generally not cash constrained even though Malende seems to be 'richer' than Koudandeng. Income from agriculture is generally higher for Malende than for Koudandeng.

Evaluating the acceptability of cassava HYVs among households and the implications for food security and income requires a comparison of two villages on the basis of their access to cassava HYVs and extension services. If farmers' access to HYVs is limited, then the arguments put forth in this dissertation in relation to the acceptability of the HYVs have less basis. The discussions in Chapter 2 show that Obala and Muyuka sub-divisions, to which Koudandeng and Malende belong, have been the subject of more research and extension intervention compared to all other regions of Cameroon. However, Malende has had more interventions on the part of state and NGOs relative to Koudandeng. Access to extension and research outreach is limited in Koudandeng, but farmers are aware of and can obtain HYVs, whereas in Malende, extension and research outreach are consistent and focused.

The purpose for which crops are grown partly determines the acceptability of different varieties, including HYVs. When the crop is a dietary staple, households tend to maintain a diversity of varieties for a number of reasons, including hedging against production risks, ensuring food security, and meeting cultural needs (e.g. for traditional dishes), and varieties that do not meet such needs will be rejected. Where the crop is produced mainly or exclusively for the market and is used only as a minor food crop, then it can be presumed that criteria associated with production risk, yield, and market demand (economic factors) determine which varieties will be grown. Comparing a village where cassava is a staple crop with a village where it is primarily a commercial crop was therefore important for this research. Cassava is a staple crop in Koudandeng, whereas it is a cash crop in Malende, and only small quantities are consumed.

As discussed in section 3.2.3 above and in chapters 2 and 6, culture is central to livelihoods (options and strategies). In communities that adhere more to tradition, agricultural production is less likely to be oriented toward individual profit maximisation, whereas in communities that adhere less to tradition, production may be more oriented toward profit maximisation. Different degrees of adherence to cultural tradition may influence the acceptability of cassava HYVs and other varieties, which depends on their use and exchange values. The two villages differ in the degree of adherence to tradition, where Koudandeng has a more homogeneous ethnic composition with a stable native population that adheres more to traditions, whereas Malende has a heterogeneous ethnic composition that is composed largely of migrants. However, in both villages, the farming systems are similar (predominantly polyculture) and Christianity is the predominant religion. These villages also differ in their educational system, where Koudandeng is involved in the French system, and the English system predominates in Malende.

In summary, similarities in agroecological potentials for cassava production and access to cassava markets, production resources, cassava HYVs, and research and extension institutions, and the differences in the orientation of cassava production and degrees of adherence to cultural traditions, indicate that Malende and Koudandeng villages are close to ideal for comparison, with the limitations and exceptions noted above.

3.3.2 Selection of Study Sites

The two types of surveys that were judged most appropriate and thus employed in the selection of a second, more subsistence-oriented village were the market and village reconnaissance surveys. A reconnaissance survey of the three main food markets of Yaounde (Mfoundi, Mokolo and Mvog-mbi) was used to determine the major areas of supply for the three principal cassava products (fresh tubers, baton, and couscous) in the Lekie Division of the Centre Province. It was carried out in February to March 2002. Results of the interview with 54 randomly selected male and female retailers and wholesalers identified Obala Subdivision in Lekie Administrative Division as the main source of the cassava roots and baton in the three markets. Further interviews of 29 cassava retailers and consumers in Obala's semi-urban market indicated Koudandeng and Endinding (a village neighbouring Koudandeng) villages as the main sources of supply of cassava tubers and baton.

A nine-day reconnaissance survey using focus group discussions (17 informants in Endinding, 23 informants in Koudandeng) was done in November 2002 to gather the necessary socio-economic, agricultural, and cultural data that provided the framework for further in-depth investigation, and to familiarize the researcher with the villages. While the results of this survey provided insights that could be used to develop broader qualitative and quantitative research methods, questionnaires, and other instruments, the parameters identified were used to design a household census questionnaire that was subsequently used to identify the sample population required for the research in Koudandeng, which was the village that was finally selected because it was more integrated into cassava markets compared to Endinding.

3.3.3 Sampling Rationale and Procedures

Table 3.2 presents a summary of the various methods used, the type of information generated and the number of informants involved. The main unit of analysis in this research was the household, although a substantial amount of data was collected from individual cassava farmers. A household as defined in this thesis refers to a unit of collective decision-making where members eat from the same pot. For this research, the households of interest were those involved in cassava production. A household census was carried out in Koudandeng and Malende in 2002 - 2003 to determine which households were producing cassava in the study sites (the questionnaire is found as Appendix A). As national-level census data on the households were not available and, even if available, would have been outdated, an enumeration of households was attempted. In Koudandeng, a total of 116 households were visited and a census interview was conducted with any available adult member of the household. It is estimated that 11 households (8.6% of total) were not included in the census because, at the time of the interview, there was no adult present. In Malende, a total of 92 households were censused out of an estimated total of 120 households. There was a higher rate of absenteeism in Malende (no one was present in 24 households) as interviews coincided in some cases with market days and dry season funeral celebrations. An additional three households refused interviews, in one case the spouse of the household head wanted to first consult her husband and, in two instances, outright refusals were given (one man and one women refused), perhaps because of misperceptions regarding tax collection. One household did not produce cassava. The households that are located within the CDC camps that surround Malende were not included in the census.

A total of 206 cassava-producing households were censused. While all of the households in Koudandeng were involved in cassava production, one Malende household did not produce cassava (headed by a young unmarried female teacher). The household census questionnaire was also designed to permit stratification of households according to variables identified as potentially important to understanding variation within the research population during the reconnaissance work that was carried out in Koudandeng in November 2002. It was found that variables that may influence cassava varietal diversity, livelihood strategies, and production orientation included: household size and headship, land tenure, scale and extent of cassava production and commercialisation (households' production orientation or objectives), cassava cultivar diversity, extent of specialisation in the cassava production cycle, ethnicity and place of origin, and access to research and extension services.

Multi-staged sampling was then used to select the study sample. First of all, a sample was selected on the basis of all of the censused households, and all other sub-samples were selected from this sample population. A total of 66 households (34 from Malende, 34 from Koudandeng) were selected by means of a stratified random sampling procedure. This represented 27.5% (28.3% for Malende, 26.7% for Koudandeng) of the estimated total cassava-producing households in the study area. Given the ethnic diversity of Malende and the variation in socio-economic characteristics of farmers and farm households in both villages, it was necessary to ensure that a sufficient number of farmers from various social strata were included, if complete knowledge of these domains was to be obtained.

Table 3.2 Data Collection Methods, Data Generated, Sample Sizes, and Informants

Method	*Data Generated*	*Sample Size and Informants*
Market Reconnaissance Surveys	Identified Koudandeng as a major area of supply for fresh tubers and baton in Obala semi-urban and Yaounde urban food markets.	83 sellers**:** 54 in Yaounde markets; 29 in Obala market)
Reconnaissance Survey	Socio-economic, agricultural and cultural data that provided the framework for further in-depth investigation.	40 male and female villagers
Household Census	Household size and headship, land tenure, scale and extent of cassava production and commercialisation (production orientation or objectives), cassava cultivar diversity, specialisation in the cassava production cycle, ethnicity and place of origin, and access to research and extension services.	206 HH: 116 HH in Koudandeng, 92 HH in Malende
Stratified and Multi-staged Sampling	Selection of sample population of households to be used as the main unit of research	68 HH: 34 in Malende, 34 in Koudandeng; five sub-samples in Koudandeng and two in Malende
	Sub-sample of individual cassava producers for analysing cassava varietal diversity, knowledge, language, and culture	114 cassava producers: 55 in Malende, 59 in Koudandeng
Household Survey	Household demographic and socioeconomic and economic variables, land tenancy, livelihoods options, agricultural activities (crop production and sale, livestock rearing and sale), household labour and income.	68 HH: 34 in Malende, 34 in Koudandeng. 127 participants: 58 men and 69 women
Cassava Survey	Issues related to cassava production such as inputs, labour organisation, cassava varieties managed, farming systems, production and sales, and social organisations.	68 HH: 34 in Malende, 34 in Koudandeng; 83 participants: 19 men and 64 women
Health Survey	The type of prolonged or repeated illnesses that household members suffered or are suffering from within the last five years, existence of orphan children in the households studied and the causes of death of their deceased parents, household members membership in health associations and the reasons why, and deaths of household members or relations within the last five years and the causes of death	68 HH: 34 in Malende, 34 in Koudandeng; 68 participants: 18 men and 50 women
Qualitative structured and unstructured interviews	Cultural values, norms and beliefs, transfer or inheritance of property, and settlement patterns and forms of organisation of marriages and households and their shifts over time.	7 focus groups: 5 in Koudandeng, 2 in Malende; 5 individuals in Koudandeng: 2 male, 3 female

Table 3.2 Data Collection Methods, Data Generated, Sample Sizes, and Informants (con't.)

Method	*Data Generated*	*Sample Size and Informants*
Participant observation	Steps and labour time involved in cassava processing (processing procedure), cassava marketing and events that highlight the culture (norms, values, beliefs) of the people of Koudandeng, and to clarify issues related to the data collected using surveys and interviews. Also, to understand the differences and similarities among the various cassava varieties that were listed	4 HH processing cassava, 2 HH harvesting cassava, 12 HH selling cassava Events: 3 wrestling matches, 2 funerals 1 traditional marriage
Ethnobiological methods: 1. Freelisting	1) Cassava varieties managed in both villages and their salience that generates data for qualitative discussion on the reasons for varietal loss or maintenance, and that generates data to be used in other data collection and analysis techniques such as triads testing, consensus analysis, multidimensional scaling (MDS) and test statistics.	114 farmers: 59 in Koudandeng, 55 in Malende, with 19 men (2 Koudandeng, 17 Malende)
2. Triad testing	Data related to an understanding of farmers' perceptions of the cassava varieties that they grow by analysing how and why they group these varieties and to discover which dimensions farmers use to evaluate and classify the varieties. In this, identifying varietal attributes and clusters that appear to order the varieties along a continuum of human plant relations	same as Freelisting
Follow up interviews to freelisting exercise	Information obtained to facilitate data cleaning, understand the meaning behind the naming of cassava varieties, the varieties grown or abandoned and related reasons and local research institutions' activities in cassava varietal development and dissemination and relationship with farmers and extension.	114 farmers Researchers: 2 IITA staff, 1 IRAD staff

HIV/AIDS afflicted households and polygamous, dual headed and single headed households were purposively selected. Willingness to participate in the research was another important selection criterion. Based on this, four strata of households were identified and used to classify the households censused in 2002-2003. An additional stratum based on ethnicity was included in the Malende selection criteria. Table 3.3 depicts the number of households that were selected per strata in both villages. The information on HIV/AIDS status was obtained from discussions with two members of the local Committee for the Control of HIV/AIDS in Muyuka and Koudandeng. The member for Muyuka is also the Zonal Extension Worker (ZEW) in charge of Malende zone, of the Sub-divisional Delegation of Agriculture for Muyuka. However, the results of the health survey module that was administered as part of the current research showed that more households were HIV/AIDS afflicted (see Chapter 5 for detailed discussions).

Smaller samples (subsets) of the total sample population were selected and used to collect some specific data as deemed relevant. The choice of each sub-sample was based on preliminary analysis of the previous data collected. In all five sub-samples (one five-member male sub-sample, two five to seven-member female sub-samples, one eight-member sub-sample of male youths, and one group consisting of two local health assistants) were identified and used in Koudandeng. In Malende, two sub-samples were made of 10 adult male and 20 adult female farmers. Individual farmers were also interviewed as deemed necessary.

Table 3.3 Number of Cassava-producing Sample Population Households per Selection Strata

Strata Category		*Number of Households*	
		Malende HH	*Koudandeng HH*
Household Headship	Dual	6	6
	Female	3	3
Form of Marriage	Polygamous	1	3
	Monogamous	5	8
Degree of commercialisation	Commercially oriented	8	10
	Subsistence oriented	-	3
Household HIV/AIDS status	Afflicted households	4	3
Native/Migrant Status	Migrant	5	-
	Native	2	-
Total		34	34

Source: Household survey and HIV/AIDS survey

Respondents for the freelisting and triads testing exercises described in detail below and in Chapter 5 were selected from members of the stratified random sample population of 68 households that participated in the household and cassava surveys as well as among members of 20 other households in the two villages who were willing to participate in the exercises. Thus, respondents were selected from 88 households, which represent 35.6% of the estimated total number of cassava-producing households in both villages. Limiting data collection to only those members of the households that participated in the household and cassava survey might not have provided the exhaustive list of cassava varieties that was required. For example, in Malende, two native Balong speakers who did not participate in the survey named two varieties (old stick and melong stick) that were not named by other survey participants. In Koudandeng, where mainly women grow cassava, men did not want to participate in the exercise because they did not feel that it was culturally appropriate for them to talk about 'women's' crops. Asking a man to participate in the interview was often led to this type of response: "Cassava is a women's crop, you better talk to women. If you were interested in cocoa and oil palms then I would have liked to participate."

The selection criteria for both the freelisting and triad tests were, therefore: belonging to a household that was involved in the survey, being a cassava farmer, and willingness to participate. Likewise, it was important to ensure that HIV/AIDS affected households were included. The respondents were not selected randomly but consisted of all the members of the sample population households and a few others who indicated that they grow cassava and were willing to participate in the research. In total, one hundred and fourteen (114) farmers were interviewed using this technique, where 55 were from Malende and 59 were from Koudandeng. Eight farmers (14.5% of the sample) in Malende were interviewed who did not participate in the survey. In Koudandeng, five farmers dropped out of the interview either because of time constraints, divorce, or death in the family, and so these were replaced and 23 others who did not participate in the survey were interviewed.

3.3.4 Data Collection Methods

In order to gain greater insights into the implications of cassava commoditisation and the promotion of cassava HYVs for traditional agroecological and farming systems, for knowledge and perceptions of cassava varieties, and varieties actually grown, and food security, livelihoods, and income of farm households, a series of appropriate qualitative and quantitative methods were used. Qualitative methods included a review of grey and published literature, as well as in-depth interviews and observations. Quantitative methods included closed question surveys and cognitive ethnobiological methods (freelisting and triads testing). The methods used to collect data followed a chronological order as presented below even though at times sections of the uncompleted survey questionnaire were administered in between data collection exercises using the other methods.

3.3.4.1 Secondary data

A review of grey and published literature was ongoing throughout the research, which led to the identification and elaboration of the research topic, hypotheses, concepts, methods and research instruments. This review guided the process of thesis write up through the examples of similar cases presented in the literature. More specifically, a review of ethnobiological, sociological, and other literature was focused on policies and strategies promoting cassava production and commercialisation, cassava production statistics and market outlets, rural livelihoods, income, food and foodways, agrobiodiversity, dietary diversity and nutrition, agroecology and farming systems, varietal knowledge and perceptions, and methods. For example, grey literature (project and activity reports, online publications) and publications on the development, breeding and release of improved high yielding cassava varieties to farmers in Africa, Asia, and the Pacific was reviewed to identify researchers' breeding objectives and strategies, the varieties that have been released in Cameroon, farmers' roles in participatory plant breeding, and those aspects of farmers' knowledge that are considered in formal breeding strategies.

In Cameroon, secondary data was collected from reports of the various services of the Ministry of Agriculture and Rural Development in the Centre and South Provinces, from the Institute of Agricultural Research for Development (IARD, or IRAD, its French acronym) of the Ministry of Scientific Research and Innovation, and from the International Institute of Tropical Agriculture (IITA-Cameroon). Cameroon Government policy implementation documents such as the Rural Sector Development Strategy and the Laws and Ordinances of the Land Tenure and State Lands in Cameroon were consulted. Data were consulted on farming systems, commercialisation of food crops, food crop (cassava inclusive) production statistics, cassava markets, research orientations and strategies relating to cassava, and the different cassava varieties that have been released to Cameroonian farmers. Wageningen and Kent universities' libraries were the most important sources of secondary data (grey and refereed literature) that covered all the relevant issues discussed in this dissertation.

The 3rd National Demographic and Health Survey of 2004 by the National Institute of Statistics (2004) was reviewed to obtain data in relation to HIV/AIDS prevalence and the illnesses and their related symptoms that are used as a proxy (opportunistic illness) for HIV/AIDS. Reports of national and local HIV/AIDS control committees (CNLS, CLLS), local health centres and local NGOs working on HIV/AIDS in Muyuka and Obala could not be consulted because, according to the Cameroon medical ethics, it is forbidden to reveal the health status of individuals. To obtain the necessary data, interviews were carried out with the health personnel – anonymity has been strictly respected.

3.3.4.2 Survey research

Survey research is a structured data gathering method that allows for the collection of data for a large number of observations necessary for quantitative data analysis. It is quick to administer and exposes each respondent to the same stimuli or set of questions (Bernard, 2006) and therefore reduces interviewer bias. It was used as the main data collection instrument at household level. The purpose was to obtain data across a large number of households and to generate data on the subsets of individuals within households that are the special focus of this study. It was meant to capture all of the data on variables used for quantitative analysis and permitted the analysis of interrelations between the variables that were explored at household and individual levels. The idea was also to control the research focus and trigger responses that can be reliably compared between respondents. The main research instrument used was the questionnaire, which was administered in face-to-face interviews. The face-to-face method of administering questionnaires was necessary for collecting data with farmers, some of who could neither read nor write. The survey data was collected in four phases: the reconnaissance survey was carried out first, the household census was carried out second, the household socio-economic survey and the cassava survey were carried out third, and health survey was carried out last.

Three questionnaire modules (appendices B, C and D) were elaborated and administered in the two villages (see Table 3.4 for the data generated with each module). The first consisted of a household survey, which was administered to the study sample population (68 households: 34 in each village). The number of observations for this survey was small because of time and financial constraints. In all, 127 persons were interviewed (67 in Koudandeng, 60 in Malende). Of the 67 Koudandeng respondents, 63 (31 men, 32 women) came from dual headed households, three were female household heads, and one was a male-child household head. In the case of 60 Malende respondents, 51 (25 men, 26 women) were dual household heads and nine were single household heads (eight female heads, one male head). To administer this questionnaire in each of these households, the household demographic sheet was filled out first, which led to the identification of the household head and those who should be interviewed. In all the heads of households were interviewed and, in the case of dual headed households (married couples), the wife was interviewed in relation the socioeconomic data of the household and her agricultural activities, whereas the husband was interviewed in relation to his own activities and socioeconomic data. Interviews were often conducted separately to avoid interference, to ensure respondent confidentiality, and to permit scheduling interviews based on the availability of the respondent. At times, the couple was interviewed together on general issues, and sensitive issues such as sources of income and savings and other financial issues, marital problems, income expenditure, and gender divisions of roles and tasks in agriculture, were discussed separately with the individuals concerned. In the case of polygamous households, administering the questionnaire to all the wives depended on their willingness to participate. For example in Koudandeng, co-wives (four women) from two polygamous households were administered the questionnaire but one woman was later on dropped because of divorce. In this case, the household level data, which was the first section of the questionnaire, was collected in a focus group discussion with the two wives and their husband who at that tie were still enthusiastic about the research.

The second module consisted of a cassava survey, which was administered to the cassava-producing members of the 68 households. In Koudandeng, the task of selecting who should participate in the survey was easier compared with Malende, because of the belief in the former village that cassava is a women's crop so that men do not think it culturally appropriate for them to discuss issues related to cassava. This lead to the selection of female heads (from dual and single headed households) and two male household heads who were willing to participate in the survey. The selection task in Malende was more difficult because the household survey that preceded the cassava survey was considered to be tedious and time consuming, so most farmers were unwilling to participate. As such, the choice was based solely on which of the household heads who was also a cassava farmer was willing to participate. In some households, both men and women heads participated, whereas in others, either men or women participated. In total, 83 persons participated in this survey (36 in Koudandeng, 47 in Malende). Of the 36 Koudandeng participants, 34 were women and two were men, whereas in the case of the 47 Malende participants, 17 were men and 30 were women.

A third module consisted of a household health survey whose content permitted the identification of the HIV/AIDS status of households. It was administered to all 68 households where 68 persons participated (34 from Malende, 34 from Koudandeng), 18 of who were men and 50 of who were women. At the time when this questionnaire was being administered, the researcher had developed sufficient rapport and trust with most of the interviewees and so could easily approach them. In most cases, women participated in this survey because they could easily discuss sensitive health issues with a female researcher. The list of proxy-illnesses used to elaborate the questionnaire was developed from interviews with health personnel and a literature review (see above). Rather than directly asking about HIV/AIDS status, proxy-illnesses were used to avoid stigmatising respondents and respondent refusal to be interviewed. While the household and cassava survey modules were implemented earlier in the research process, the health module was administered last so that participants would be less likely to refuse to participate.

The household and cassava survey questionnaires were pre-tested and modified before administering them, and sections were re-modified when deemed necessary as the questionnaire administration exercise progressed.

3.3.4.3 Qualitative structured and unstructured interviews

Qualitative interviewing is a data collection method that enables respondents to open up to the researcher and express themselves in their own terms (Bernard, 2006) and at their own pace. Unstructured and structured interviews were used to gather the necessary socio-cultural data that could not be effectively gathered using quantitative methods. Qualitative interviewing was used to further deepen understanding of issues raised during the survey research (e.g. knowledge in cassava processing). Discussions were held either in focus groups or individually. Unstructured interviews, or ethnographic interviewing, was most often used to discuss issues related to people's lived experiences, history, and events, such as the origin and administrative structure of the villages, the HIV/AIDS pandemic, and the HIV/AIDS status of households. The topics that formed the basis of discussions were obtained from preliminary analysis of data obtained using other methods. The main unit of research was the individual, but at times the unit was the village as a whole.

Semi-structured, in-depth interviews were done to collect data on cultural values, norms, and beliefs, transfer or inheritance of property, and settlement patterns and forms of organisation of marriages and households and their dynamics over time. An interview schedule or checklist questionnaire was elaborated and used to guide the discussions. The purpose was to have a general overview of the socio-cultural and organisational structure of the two villages and to capture how cultural norms, values, and beliefs affect cassava production and sales and cassava genetic diversity and management. The main units of analysis were focus groups and individuals. Seven focus groups were used (five in Koudandeng, two in Malende). As discussed above, the composition of the focus groups was as follows: in Koudandeng - one five-member male sub-sample, two female sub-samples (one with five members, one with seven members), one eight-member sub-sample of male youths, and one group consisting of two local health assistants. In Malende, a 10-member sub-sample of adult males and a 20-member sub-sample of female farmers were interviewed. Various individuals were interviewed including the representative of the Koudandeng Village Chief and the Chief of Malende. Most of the individuals interviewed were those judged to be quite knowledgeable about specific topics. For example, an elderly man (79 years old) was interviewed with respect to the shifts in the norms, values, and beliefs and major events in Koudandeng. Three women were interviewed individually for their knowledge of cassava varieties in Koudandeng.

Interviews were concentrated more in Koudandeng, which has a more subsistence oriented, ethnically homogenous and traditional culture, so as to gain insights into the ways in which policies that promote cassava HYVs may impact more traditional cultural norms, values, and beliefs in relation to cassava production and sales and cassava genetic diversity and management. Due to the ethnic diversity in Malende, this would have been difficult. Some of the interview schedules are presented as Appendix E.

3.3.4.4 Participant observation

Participant observation was used to collect complementary data to that obtained through the survey questionnaires and interviews. It was also used to observe cassava processing and other informal events. The data collected was analysed and used to enhance the discussions in chapters 4 and 6. Modified forms of participant observation were used, such as situational observation and time and event sampling (van Willingen and Dewalt, 1985). Participant observation is a data gathering technique that is central to the ethnographic process, and is almost synonymous with anthropological fieldwork. The purpose of carrying out participant observation was to produce comprehensive accounts of the steps and labour time involved in cassava processing (processing procedure), cassava marketing, and events that highlight the culture (norms, values, beliefs) of the people of Koudandeng, and to clarify issues related to the data collected using surveys and interviews. The principle means of collecting information in an observation is either by experiencing something directly or by having someone tell you what happened. There are therefore two types of observations: 1) watching what people do and recording what they say, and 2) asking people about their own actions and the behaviour of others (van Willingen and Dewalt, 1985; Bernard, 2006). These two modes of access to information were used to collect data in the participant observation process to avoid problems of reliability and validity of data and of missing out important aspects of the observed behaviours. This was also to keep the researcher's own experience, knowledge, and interpretation out of the observational picture as much as possible. Smaller segments of behaviour were taken as the units of observation.

Situational observation - a modified form of participant observation - was used to document the processes of cassava processing for a sub-sample of two households each in Koudandeng and Malende. In two instances in Koudandeng, I participated in cassava harvesting with two different households, and used this opportunity to further deepen my understanding of the differences and similarities among the various cassava varieties, which helped to refine the data.

In Koudandeng, event sampling, which is the selection for observation of integral behavioural occurrences, was used to observe events such as funerals (burial ceremonies), traditional wrestling, and marriages. Funeral ceremonies were observed on two occasions; three organised traditional wrestling events among male youths were observed, as well as one aspect of a traditional marriage (women preparing the groundnut pudding delicacy and a large long *ndeng*.

Time sampling, which is the selection of behavioural units for observation at different points in time, was employed in the observation of cassava marketing, where the sales locations, times, and dates are specific - farm gate, home-based, village and urban markets held every eight days in the case of Malende, and on Saturdays and Sundays in the case of Koudandeng. Time sampling was done randomly and at least six households in each village were observed for one hour on a periodic basis.

3.3.4.5 Ethnobiological methods

Three methods were considered to be most appropriate for the systematic collection of data that permits one to uncover farmers' ethnobiological knowledge in a given cultural domain, such as that of cassava diversity, and to link this knowledge to farmer behaviour in cassava diversity management: freelisting, triads testing, and unstructured interviews (follow-up questions to freelisting exercise). The main reason for combining these methods was to understand farmers' interpretation of the content of the domain and how the varieties are related to each other in farmers' minds. According to Puri and Vogl (2005), cultural domains are necessary for perceiving, interpreting, and communicating one's experiences with the world and are therefore the starting point for studying people's perceptions. Because cultural domains are important aspects of local or indigenous knowledge, the identification of the domain 'cassava varieties' and how it is structured was the first step in understanding farmers' cassava varietal knowledge and diversity and how these differ or vary among farmer subgroups, or categories. The basic concept behind each method is presented below, and a detailed discussion of each method and its application is presented in Chapter 5.

a) Freelisting

Freelisting is both a theory and a method. As a theory, it is a way of understanding how people in a given culture define their world. It is also a means to identify salient (meaningful) terms in a cultural domain and to find out where to concentrate effort in a domain or in applied research. In this, the frequency and order of mention of items in individual informant lists highlights which items are more salient. It is assumed that the first items that are mentioned are more meaningful to the informant in comparison with items that are mentioned later - that is, the freelist presents an implicit rank order of importance or meaningfulness to the respondent. In analysing freelist data, the order (sequence) and frequency of mention of terms freelisted is important since the main interest is in understanding the underlying cognitive structure of the domain under study. Borgatti (1996a) noted that the order of items in a given list reflects saliency, and that saliency could also be interpreted to mean prototypicality (typifying a category of items). In interpreting saliency data, the assumption is that, the nearer the name of an item (e.g. a cassava variety) is to the top of the list, the more salient it is for each informant as compared to those that are mentioned last and least often. The Saliency Index proposed by Smith was judged useful for this measure because it takes into consideration the frequency and order (position, sequence) of mention of the items in the domain (e.g. varieties).

As a method, freelisting is good for eliciting the items that constitute a cultural domain. The importance of using this method in this research lies in the fact that it a) is a deceptively simple but powerful technique for eliciting items in a cultural domain with intra-cultural variation (Bernard, 1995, 2006); b) provides a first approximation of knowledge and salience of the different cassava varieties for different farmers, c) generates data for qualitative discussion of the reasons for varietal loss or maintenance (varieties known, grown, abandoned, never grown); d) reveals variation in expertise in the culture and provides a measure of culturally important items (Price, 2001); e) data collected using this technique is easily analysed both manually in the field and using the ANTHROPAC statistical program; and f) it permits the collection of data to be used in other data collection and analysis techniques such as triads testing, consensus analysis, multidimensional scaling (MDS) and test statistics (regression, chi squared). Price (2001) and Bernard (2006) have noted that freelisting is often a prelude to cluster analysis and multidimensional scaling.

The methodology section in Chapter 5 discusses how freelisting was applied to data collection about cassava varieties in the study areas. The freelisting and follow-up research instrument is attached as Appendix F of this thesis.

b) Triads testing

Triads testing is a technique that enables differences in cognition of the items of a cultural domain (in this case cassava varieties) to be explored across informants. Triads are used to discover relationships between items in a domain as perceived by informants (Puri and Vogl, 2005); to understand how and why informants group items in a cultural domain; to map the structure of a domain and the dimensions for classifying them within it (Borgatti, 1996a, 1996b); to understand intra-cultural variation within a specific domain (Lieberman and Dressler cited in Bernard, 2006), and to study cognition and saliency (Romney and d’Andrade cited in Bernard, 2006). Triads testing was used in this research to understand farmers’ perceptions of the cassava varieties that they grow by analysing how and why they group these varieties, and to discover which dimensions they use to evaluate and classify them. In this, identifying varietal attributes and clusters that appear to order the varieties along a continuum of human-plant relations can help to:

a. Identify those varieties that are at risk of disappearing;
b. Identify the most meaningful varietal attributes that may be useful for breeding programmes and government interventions;
c. Gain insights into the way farmers perceive which characteristics are important and how they tend to group varieties, which can then be compared with the varieties that they grow,
d. Relate attributes and varietal groups to farmers' food security, food processing and livelihood strategies, household economies and their agroecological niches; and
e. Knowledge of farmers' understanding of the similarities and differences between varieties provides baseline information for understanding the relationship between varieties and farmers' agroecological systems, processing, food security and livelihood options (income earning, labour and land allocation).

The importance of this technique rests in the fact that it is a powerful tool for generating data that is used for proximities analysis through cluster analysis and multidimensional scaling (MDS), where proximities are measures of perceived similarities or dissimilarities among a set of items such as cassava varieties. It limits the cognitive burden on farmers by giving them a very simple set of tasks where the data generated reveals their perceptions of the degree of similarity between all pairs of items (cassava varieties) and, at the same time, it is interesting to administer both for the researcher and for the informant. Triads testing does not impose any kind of grouping of the items from an etic (outsider) perspective; there are no right or wrong answers to a question or triad. It is good for domains with few items (less than 30), and it is productive because it is easy to administer, score, and analyse with ANTHROPAC. Puri and Vogl (2005) noted that, by using this technique, a basic classification system can emerge that may or may not resemble a taxonomy, but that can be used to compare with the responses of informants from other cultures and sub-cultures.

The basic principle behind triads testing is that exposing people to a judiciously chosen set of triad stimuli can facilitate an understanding of individual similarities and differences in how people think about the items in a cultural domain. This is because items that fit together or are similar, group together, as compared to items that are dissimilar, and that do not group together, and because farmers express their reasons for grouping specific items together. Out of three items (a triad) (e.g. three different cassava varieties) that are presented to them, informants are requested to choose the two that are the most different or the most similar, and to mention why.

The formula for calculating the number of triads is adapted from Bernard (2006) and Puri and Vogl (2005) as follows:

$$\text{The number of triads in n terms or items} = \frac{n(n-1)(n-2)}{6} = \text{number of combinations}$$

Where n = number of items in a domain

In constructing a triads test questionnaire, it is important to randomise the order of the items within each triad and the order of presentation of the triads to informants, since each set of three items can generate answers that influence answers to the next triad. Bernard (2006: 311) calls such influences order-effects, which are possible biases that come from responding to a list of stimuli in a particular order. Randomisation requires the application of a specific design or pattern that specifies which triads should appear and in which order.

The items used in this research for constructing a triads test questionnaire came from the freelist data that was collected with farmers in Malende and Koudandeng. The freelisting exercise generated a total of 16 cassava varieties for Malende and 28 varieties for Koudandeng. Ideally in triads testing, all possible combinations of all items freelisted should be presented to respondents for judgement, which is painstaking and time consuming. Considering that each pair of items in a domain occurs n-2 times (where n = number of items), and each item occurs (n-1)(n-2)/2 times, the number of triads increases by the cube of the number of items, thus resulting in too many triads to be reasonably tested. If all of the cassava varieties listed were included, then 16 varieties would have formed 560 triads or combinations for Malende, and 28 varieties would have formed 3276 triads for Koudandeng. In order to reduce the boredom of administering these questionnaires, the redundancy involved and the cognitive burden on respondents, a fractional factorial design was used instead of a full factorial design.

Here, the fractional factorial design developed by Burton and Nerlove (1976, cited in Bernard, 2006) called the balanced incomplete block design (BIB) was applied. BIB designs take advantage of the redundancy in a triads test and thus reduce the number of triads to be administered by presenting each pair of items only a limited number of times. The number of times that each pair of items occurs is called lambda (λ). The $\lambda = 2$ design was chosen, reducing the number of triads to be administered per questionnaire per farmer to 30 for Malende, and to 70 for Koudandeng. Also, the accuracy and reliability of the data collected is high because the aggregate similarity of any given pair of varieties is not determined by any single third item (which may be unusually different even though the other pair of varieties is not particularly similar). The information about how triads testing was used to collect data on farmers' perceptions of cassava varieties is detailed in Chapter 5. The triads test questionnaire is presented as Appendix G.

c) Follow-up interviews

Interviews were carried out with farmers in follow-up to the freelisting exercise to facilitate data cleaning and understand the meaning behind cassava varietal names. Interviews were also subsequently carried out with researchers from local research institutions (IRAD, IITA - Cameroon) in relation to their activities in cassava varietal development and dissemination and their relationship with farmers and extension. Refer to Chapter 5 for further details.

3.3.5 Data Analysis Methods

3.3.5.1 Qualitative methods

Qualitative interview data were coded and analysed narratively (description, explanation, interpretation, quotations) using Microsoft Word®. Diagrams and photographs were also used to illustrate some of the important points.

3.3.5.2 Quantitative methods

The main software packages used for analysing quantitative data were Microsoft Excel®, SPSS®, and ANTHROPAC. Microsoft Excel® was used as the main data processing software and to analysis descriptive statistics at least in a preliminary way. SPSS® was used to run descriptive analysis and regression analysis of the survey data and some freelisting and triads testing data (reasons for managing cassava varieties, varietal characteristics/attributes, and socioeconomic variables). ANTHROPAC was the main statistical package that was used to analyse freelist and triads test data.

The data collected using the different survey research modules and ethnobiological methods (freelisting, triads testing) were entered into Microsoft Excel® and cleaned. Cleaning was done by auto-filtering the data in each column to identify missing data and errors that were subsequently either corrected by referring to the original instrument or by annulment in the case of lack of sufficient clarifications.

The small household sample size did not permit the use of more sophisticated statistical analyses by sub-groups within villages, which generally limited the analysis of survey data to that which could be done using descriptive statistics, such as proportions, percentages, and frequencies.

3.3.5.3 Cultural consensus analysis

Cultural consensus analysis is a technique that is used to assess the degree of (high) agreement or the existence of one response pattern among informants in a given set of data. It is used to estimate culturally correct answers and the cultural knowledge or accuracy of informants (Weller, 2007). The basic principle behind consensus analysis is that culture is shared, but variation exists within a given culture (Price, 2001; Borgatti, 1996a; Weller, 2007). Individual differences may result from factors that may include socio-economic characteristics as well as idiosyncrasies. The cultural consensus model is an aggregative technique or cognitive model that describes the processes and parameters involved in answering questions (Weller, 2007). In this model, it is assumed that the researcher does not know the answers to the question or the competence (accuracy) of the individuals in answering the questions. The cultural consensus model therefore is an approach that helps to differentiate between what is shared knowledge and what is idiosyncratic knowledge of individuals. Consensus analysis is both a theory and a method (Borgatti, 1996a, 1996b; Weller, 2007). As a theory, it specifies the conditions under which more agreement among individuals on the right answers to a "test" (question) indicates more knowledge. It is assumed that there is no right or wrong answer and, thus, similarity of responses or agreement between respondents is an indication of each respondent's knowledge of the items in a domain. As a method, consensus analysis provides a way to reveal the culturally correct answers to a set of questions in a situation where intra-cultural variability exists.

Cultural consensus was used to analyse the freelist data. Farmers were not subjected to a multiple choice test composed of the different cassava varieties listed;: instead, cultural consensus analysis was used to assess the level of agreement of each respondent with the group in relation to the cassava varieties listed. Individuals' agreement with the group in listing the varieties is a product of culturally defined concepts, and thus knowing the variety is a function of one's access to the cultural knowledge of a given group.

Three assumptions embedded within consensus analysis are:

- The existence of one culture. Whatever cultural reality might be, it is the same for every informant - there are no subcultures that have systematically different views on the domain. All variability in naming the items on the list is due to variation in knowledge. This means that there must be a high level of consistency (agreement) in responses or one response pattern among informants;
- Independence: the only force drawing people to a given answer or naming a particular item is the culturally correct answer. When informants don't know an answer, they choose or make up one independently of each other;
- One domain: all questions are drawn from the same domain.

Consensus analysis virtually tests whether these assumptions hold or not (validity) by computing factor loadings called eigenvalues. Using ANTHROPAC, the cultural consensus model first of all estimates individual competencies before estimating the agreement between respondents. This involves factoring the inter-informant agreement matrix with minimum residual factor analysis (minimum likelihood factor analysis for ordinal/interval scale data) to compute the eigenvalues so as to verify whether the inter-informant agreement matrix fits the consensus model. For the data to fit the 'one culture' assumption, only one large eigenvalue should exist in the model. Two or more large eigenvalues are evidence of the existence of two systematically different patterns of responses or 'truths'. The rule of thumb is that, if the ratio of the eigenvalues of the first factor to the second factor is less than three to one (3:1), then the assumption of a single culture is indefensible. If data fit with the cultural consensus model, then informants share knowledge about the items in a domain.

The agreement between respondents is the product of their respective competencies. Cultural competence is the expertise of each individual with regard to naming the items in a domain. In this research, it indicates the proportion of cassava varieties that each farmer knows and is therefore a description of the fact that some farmers are more knowledgeable of cassava varieties than others.

Using the match method, Weller (2007) notes that cultural competence scores are estimated from pairwise similarity in responses between all pairs of informants. This model only accommodates categorical-type response data, and so agreement between pairs of informants was calculated with the proportion of identical answers (matches) between them. This model can also handle responses to open ended questions where responses are in the form of a single-word or of short phrases, and it was therefore useful for the analysis of farmers' freelist data on cassava varieties, which are single word answers. The details on how this method was used to analyse farmers' freelist data are discussed in Chapter 5.

3.3.5.4 Proximities Analysis and Multidimensional Scaling

Proximities are measurements of the similarities or dissimilarities among a set of items such as farmer characteristics, or attributes. The objective of measuring proximities is to map the structure of the domain of farmers so as to identify existing sub groups and the dimensions (attributes) that determine knowledge and the diversity of cassava varieties. The essence is to examine the variables (attributes) along which farmers tend to form clusters. In other words, it is to verify whether or not there are groups of farmers who have similar socio-economic attributes across the knowledge of cassava varieties, but which differ from the pattern of attributes of other farmer groups. For example, farmers may cluster together because they a closer age range, have the same level of education, the same HIV/AIDS household status, or grow many or few varieties. Price (2001) noted that the analysis of proximities can also be a useful procedure for distinguishing between differences in knowledge.

Proximities analysis was also used to map the structure of the domain of cassava varieties in order to identify the existing sub groups to which each cassava variety pertains according to farmers' perceptions. The essence of deriving proximities was to examine the varieties that tend to form clusters such that, if one has an attribute, then all the other varieties in that cluster should have the same or similar attribute as well. In other words, the essence is to find out which varieties have similar attributes and which differ from the pattern of attributes of other groups of varieties as perceived by farmers.

Multidimensional scaling (MDS) is a way to visually represent patterns of similarities or distances among objects. According to Borgatti (1996a), MDS is used to provide a visual representation of a complex set of relations that can be scanned at a glance. It is a descriptive tool for exploring relations among items in a matrix (Bernard, 2006). It was used in this analysis to visually represent the perceived similarities among farmers' socioeconomic characteristics (attributes) that seem to influence the diversity of their knowledge of cassava varieties. MDS plots the attributes/farmers on the map such that farmers that are perceived to be closer to each other are placed near each other, and farmers that are perceived to be different from each other are placed far away from each other.

The input dataset for MDS is a square symmetric 1-mode proximities matrix that indicates relationships among a set of items. The analytical process is such that MDS finds an optimal configuration of points in a p-dimensional space, such that the matrix of Euclidean distances among them corresponds as closely as possible to some function of the input matrix according to a criterion function called stress. Stress is a function that inversely measures the level of correspondence between the distances among points on the MDS map and the input proximities matrix. The smaller the stress value, the greater the correspondence between the two points and, thus, the better the representation on the map. High stress value implies that there is an imperfect and distorted representation of the relationships in the data and so the MDS is not a good way of representing it. The stress function used in ANTHROPAC is called "Kruskal Stress". The rule of thumb is that, for an MDS map to be a good representation of the perceived relationships or similarities between respondents (items), a stress function under 0.1 is tolerable, and above 0.15 is unacceptable.

In analysing MDS, one looks for clusters and dimensions. Clusters are groups of items (farmers) that are closer to each other than to others. Since the intention is to look for relationships between the input proximities matrix and the distances among points on the map, a +ve sign on the map implies that the smaller the input proximity, the closer (smaller) the distance between points and vice versa. Dimensions are the attributes that seem to order the farmers on the map along a continuum. Underlying dimensions are thought to explain perceived similarities between farmers. The implicit model of how similarity judgements are made is that items (farmers) have attributes to varying degrees, and the similarity between farmers is a function of the similarity of their scores across all attributes. Scores are perceived as weighted sum of similarities across each attribute where the weights reflect the importance or salience of the attribute (Borgatti, 1996a). Dimensions (attributes) do not necessarily correspond in number or direction to the mathematical dimensions (axes) that define the vector space or MDS map. Human dimensions are cognitively distinct and may be highly interrelated; are not necessarily perpendicular (at right angle) to each other; and may be more than the mathematical dimensions that are used to reproduce the observed patterns. It is important to note that dimensions as perceived by researchers may be different from the dimensions perceived by farmers.

3.3.5.5 Cluster Analysis

Cluster Analysis is a multivariate analysis technique that seeks to organise information about variables so that relatively homogeneous groups, or "clusters," can be formed. The clusters formed with this family of methods should be highly internally homogenous (members are similar to one another) and highly externally heterogeneous (members are *not* like members of other clusters). Cluster analysis is one of the simplest and most common ways of analysing proximities data (Borgatti, 1996a; Price, 2001). It is a method that is commonly used in the analysis of respondents' classification and perceptions of cultural domains (MacQueen, 1967; Price, 2001; Gurung, 2002; Lown et al., 2009). Johnson's (1967) Hierarchical Clustering was used in this research because it is agglomerative: it starts with fewer clusters and gradually merges them into larger clusters to form a cluster diagram called a dendogram (tree diagram), thus showing the clusters that exist at each level of similarity. In cluster analysis, clusters are defined in terms of their contiguity (closeness in space) in the dendogram. The complete linkage approach (also called the maximum or diameter method) was used in the analysis of this agglomerative model because the similarities between two clusters are measured by their remotest members, and new clusters are initiated at early stages in the analysis. The cluster diagram is presented in the form of a dendogram, where the objects are the columns and the rows are the levels of clustering or iteration.

3.3.5.6 Regression analysis (Property Fitting, simple and multiple regression)

Property Fitting (PROFIT) is a method of testing hypotheses about the attributes that influence people's judgement of similarities among a set of items (Borgatti, 1996a). It is a way of testing hypotheses about underlying dimensions along which similarities exist with respect to lists. The purpose of using PROFIT was to have an objective assessment of the degree to which cassava varieties and farmers cluster according to the patterns observed on the MDS maps. This permits an understanding of the criteria that are used for assessing similarity or agreement among farmers in naming the varieties and similarities among the cassava varieties. This is because the patterns observed in the MDS may be a result of selective attention rather than true presence. PROFIT was used to determine which farmer socioeconomic attribute (dimension) drives or determines the variation in varieties named on the freelists. The input dataset for the PROFIT regression was the map coordinates and farmer attribute data.

Using ANTHROPAC, PROFIT performed a multiple regression analysis where farmer attributes or dimensions were regressed with the varieties freelisted, and where the coordinates of each farmer on the map are the independent variables and the attributes are the dependent variables. The programme performed a separate regression for each attribute. Dummy matrices were obtained for categorical variables such as sex and household

HIV/AIDS status, and this was regressed with the farmer agreement matrix of the consensus analysis. The output of the regression model was R-square statistics, which gives the amount of variation in the outcome variable that is accounted for by the model. In other words, the R-square statistics tell us the amount of variation in the varieties freelisted that is accounted for by each farmer attribute. A high R-square signifies a closer relationship and *vice versa*. In interpreting the statistics obtained, the rule of thumb is that, for dimensions with less than 20 items, an R-square value of at least 0.8 is needed to support a conclusion that a hypothesised attribute accounts for the similarities between items (Borgatti, 1996a).

PROFIT was used for this analysis because, while carrying out multiple regression, it seeks to find the linear combination of predictor variables (farmer attributes, cassava varieties) that correlate maximally with the outcome variable (varieties freelisted, varietal attributes). The model takes into account the possibility that multi-colinearity (perfect correlation) exists between intervening variables, by calculating the order of entry of each variable and the sample size to specify how much each variable accounts for the variation in the varieties listed and the significance level of each intervening variable. Survey data were also analysed using multiple regression techniques with respect to the factors that determine the lengths of fallows in the study areas.

3.3.6 Problems and Limitations in the Research and Methods

The limitations discussed in this section not only refer to the methods used, but also to the difficulties encountered in the research process.

3.3.6.1 General limitations of the research

First, the principal limitation of the research is that its scope is very broad, and insufficient resources were available to permit data to be collected on all aspects with the same degree of care and depth. In particular, agroecological analysis was carried out largely in hindsight, without soil analysis results available for the study sites, without estimating the nutrient requirements of companion crops in cassava-based polyculture fields, and with little data on the yields of cassava-based polyculture fields or on those in monoculture fields of the same size and cropping density. Nor were data collected on the nutritive value of traditional cassava-based diets and of companion crops that are grown in a cassava-based polyculture system. The collection of this type of data is in general problematic (as discussed, for example, with respect to estimates of yields in polyculture fields in Chapter 4), and would require considerably more field research time and resources. The lack of such data obviously presents limitations for the discussions and conclusions drawn, and clearly indicates areas where further research should be carried out.

Second, although I have a sound working knowledge of French, translating the research instruments into French, the language in which it was administered to participants in Koudandeng, and re-translating the responses into English before inputting these into the computer, was painstaking and time consuming and of course created scope for error.

3.3.6.2 Limitations of the methods

The time and financial constraints faced limited the research to a small household sample, which did not permit the use of more sophisticated statistical analyses by sub-groups or strata within villages, and therefore data analysis was mostly limited to descriptive statistics and qualitative analysis. The elaboration of an inordinately long household survey questionnaire made interview sessions long, which further constrained the extension of the sample population since most respondents at least at times avoided receiving the researcher and her research assistants during planned sessions.

With regard to the freelisting exercise, cassava varieties were not collected for identification since the method emphasises cognition, so it was not possible to match the names of the varieties listed in the two villages under study. Moreover, accurately identifying closely related landraces is costly and requires the use of sophisticated methods such as Isozyme patterns or DNA markers (see e.g. Colombo et al., 1998). Therefore, the data for these two villages was analyzed separately. This limits the ability to compare the villages and to compare across all farmers in the sample, but it does not limit the ability to compare within villages among farmer groups. Identification of the varieties to facilitate comparison between the villages was beyond the scope of this research. Further, comparison between men and women in Koudandeng was not possible since cassava is traditionally a women's crop and only two male producers were found (both were interviewed). Interviewing everyone in the village rather than only cassava farmers would have permitted analysis by sex and as well would have permitted more general (commonly held) knowledge to be compared with specialist producer knowledge, but the objective of this research was not to test the knowledge of the population more generally. Furthermore, as explained earlier, Koudandeng men did not find it culturally appropriate to talk about crops that are typically managed by women.

Using cultural consensus as a means of analysing farmers' knowledge of the cassava varieties was problematic because the consensus model requires that freelist data be subjected to multiple choice tests before carrying out the analysis, in order to estimate the culturally correct answers and cultural knowledge. Since the procedure for estimating culturally correct answers required corrections for 'guessing the right answer' in a multiple choice test questionnaire, this was difficult to estimate since the varieties listed were not subjected to a multiple choice test questions. Thus, only cultural agreement could be measured and analysed, and not cultural knowledge. In other words, the cultural consensus model measured the level of individual farmers' agreement with the group in listing the varieties and not the respondents' knowledge competencies *per se*.

The dataset that was used as the input for PROFIT regression using ANTHROPAC consists of the MDS map coordinates, which are used as the independent variable. This implies that the procedure for determining which farmer attributes influence the variation in naming the varieties on farmers' freelists using PROFIT regression analysis must use the outputs of consensus analysis and multidimensional scaling (MDS) rather than raw data.

CHAPTER FOUR
AGRA AND AFRICAN AGRO-ECOLOGY. AN EXPLORATION OF CASSAVA-BASED POLYCULTURE FARMING SYSTEMS

4.1 Introduction

This chapter sets out to analyse cassava farmers' agroecological systems and their capacity to ensure sustainable livelihoods through agriculture, which, it is argued here and elsewhere in this dissertation, is the prime objective of traditional and subsistence farmers in the study area and in many other areas in Africa as well as across the globe. It especially questions whether the use of chemical fertilisers, as promoted by the Cameroon Government, the Alliance for a New Green Revolution in Africa (AGRA), and other agricultural development institutions, is necessary given the resilient nature of such traditional agroecological systems, or desirable given the current and projected socio-economic conditions that farmers confront.

The chapter starts by examining some of the assumptions made by AGRA, which are also implied in the thinking behind the promotion of high yielding crop varieties and fertiliser use by the Government of Cameroon, and in international and national crop research and development efforts oriented toward breeding improved cassava cultivars. It presents the hypotheses that are examined in this chapter with respect to these assumptions. It then briefly discusses the methodology used for data collection and analysis, and then provides a background section that complements Chapter 2 on agroecology in the study area, and discusses cassava-based production systems in the study sites. The research results sections follow.

The first results section presents an overview of cassava-based polyculture systems and farmers' multiple production goals within them. The second results section discusses the problems related to the use of crop yield as a measure of productivity per unit area in traditional polyculture systems relative to monoculture systems. The third section analyses the soils in the study area and their suitability for agriculture. The fourth discusses nutrient management in traditional cassava-based polyculture fields with an emphasis on crop associations, slash-and-burn fallows, farmers' evaluation of soil fertility through vegetation cover, and crop residue management.

In the fifth results section, constraints on fertiliser use are discussed by focusing on problems related to nutrient balance calculations and institutional recommendations, the availability of appropriate fertiliser mixes that are suitable for polycultural fields, and the appropriateness of recommendations around soil fertility experimentation and testing for subsistence and traditional farmers. The use and non-use of fertiliser among farmers in the study area is examined in terms of input costs, labour costs, and the costs entailed in fertiliser use, especially for landless and women farmers. The problems related to future agrochemical markets and vulnerability are discussed with respect to oil and phosphate supplies and prices, local fertiliser supplies, and risks and health hazards. The expected mal-adaptation of traditional polyculture systems to the prescriptions of the Cameroon Government, agricultural research institutions, and AGRA is a shift to monoculture, resulting from the lack of appropriate integrated soil fertility management strategies for polyculture systems and the failure to recognise the viability and value of traditional farming practices. Mal-adaptation is examined in terms of past trends towards intensification in the form of monoculture and mechanisation. The potential negative consequences for farmers' diets and food security are briefly mentioned, and are taken up again in Chapter 6.

The chapter concludes by asking, 'Why should traditional agroecological systems be fixed when they are not broken?' It revisits the ideology that is central to AGRA and many other agricultural modernisation programmes, which insists that African farming is backward and unproductive or environmentally degrading. It highlights the inappropriateness of promoting agrochemicals as a response to the problem of African food security, and it discusses the resilience and reliability of traditional cassava polyculture systems.

4.2 AGRA-related Arguments and Research Hypotheses

When promoting a 'new green revolution' for Africa, AGRA, the Cameroon Government, and other research institutions such as the International Centre for Tropical Agriculture (CIAT) and the International Institute for Tropical Agriculture (IITA), generally assume that traditional agroecological systems and practices are neither highly productive nor sustainable. For example, AGRA argues:

> Africa is home to some of the world's most degraded soils, and three-quarters of African farmland is severely depleted. As a result, Africa simply cannot produce enough food to keep pace with its needs, and per capita food production is declining. Cereal yields in Sub-Saharan Africa averaged less than 1.3 tons per hectare in 2000, as compared to yields in East and Southeast Asia, and South Asia, of 3.4 and 2.9 tons per hectare, respectively. While other developing regions have seen cereal yields grow annually during 1980-2000 from 1.2 to 2.3 percent, cereal yields in Africa grew at an average rate of 0.7 percent, according to the World Bank. *Africa's food production lags because its soils are low in nutrients, low in organic matter and have poor water holding capacity.* Until those conditions are reversed, Africa's soils will continue to degrade and its food situation will continue to deteriorate…Africa is the world's oldest land mass, and its soils show its age. Many of Africa's soils are derived from ancient granite rocks, created during millennia of weathering. They are inherently low in plant nutrients (Bationo et al. 2006). Compounding this natural deficit, nutrients leach and are taken away from the soil and fields with every pass of the hoe and plough, with wind and water erosion, and with every harvest. *Traditionally, African farmers have used fallows to maintain soil fertility by allowing fields to go back to bush for a number of years between cultivation cycles.* The bush was cut and burnt, leaving ashes for nutrients, a few weed seeds, and a friable soil that is good for two or three years of cultivation. *As Africa's population increased over the 20th century, the cycles got progressively shorter and soils became increasingly degraded.* Fallowing is predicted to disappear entirely from 20 African countries in the next several years and is practised on less than 25 percent of land in another 29 countries (Angé, 1993). *Traditional practices have not been replaced by new methods of soil management and cropping*

> *systems due to lack of essential inputs, knowledge and incentives. Farmers' removal of the major plant nutrients and essential micronutrients for plant growth has not been offset by additions of nutrients; hence Africa's small-scale farmers are literally "mining" the soil*…Improving soil health is essential to reversing the negative trends in food production and farm incomes. *Organic matter management and judicious use of fertiliser, but neither one alone, will solve farmers' soil fertility problems.* Integrated Soil Fertility Management (ISFM) combines the use of both to increase crop yield, rebuild depleted soils and protect the natural resource base. IFSM applies locally adapted soil fertility management practices to optimise the effectiveness of fertiliser and organic inputs in crop production. Experience has shown that the highest and most sustainable gains in crop productivity per unit nutrient are achieved from mixtures of fertiliser and organic inputs (FAO, 1989; Pieri, 1989; Giller et al., 1998; Vanlauwe et al., 2001). Manufactured fertilisers are concentrated chemical forms of plant nutrients, while organic materials from sources such as manure, crop residues and compost are much more complex materials…Fertiliser use in Africa must substantially increase along with improved soil management and land husbandry to stimulate production growth, improve food security and raise rural incomes. *Lessons from research and experimentation into increasing organic matter in degraded soils through the use of low-input organic systems can also be applied.* Some of these have relied on such techniques as agro forestry, cover cropping, grain-legume rotations, intercropping and composting. *Such low-input organic systems each have advantages, but none has proven sustainable or sufficiently attractive to become widely adopted by farmers* [own emphases].[15]

Essentially, the argument is that traditional farming systems are unsustainable because soils are mined, little or no chemical fertiliser is used, and fallow periods, which in the past provided for nutrient recycling, are declining as a consequence of population growth, leading to a decline in *per capita* crop yields. The importance of nutrient recycling through the incorporation of organic materials is clearly recognised but, at the same time, it is proposed that this be achieved by introducing Western science-based Integrated Soil Fertility Management (ISFM) methods rather than by seeking to employ or regenerate traditional methods used by African farmers for centuries, even when, by own admission, such Western promoted solutions have generally not been adopted in Africa.

One problem with the analysis put forth by AGRA above is that it refers to cereal crops, whereas roots and tubers, legumes, and fruits, which are very important staple and economic crops across much of Africa, are neglected. This is not the case with CIAT, which highlights the importance of cassava and legume crops and makes proposals that are also oriented toward promoting a 'green revolution' in Africa. In 2007, the Tropical Soil Biology and Fertility Institute at CIAT (TSBF-CIAT) was given the mandate to develop concept papers on Integrated Soil Fertility Management that would enable the Bill and Melinda Gates Foundation to design an African Health Initiative, which is a component of the New Green Revolution for Africa (TSBF-CIAT, 2009). According to one of the concept papers that focuses on the humid forest zone of tropical Africa, which is Africa's cassava belt, the slash-

[1515]http/www.gatesfoundation.org/learning/pages/Africa-soils-health-progress reports.aspx; http://www.agra-alliance.org/section/work/soils and-burn farming techniques that serve as the main land clearing technology for poor farmers must eventually change to permit the development of intensive, market-oriented cropping systems so as to meet the productivity and income needs of rural households. Such intensive cropping systems should assume the form of mixed cropping of perennial and field crops that require conventional agricultural management skills as well as increases in capital, labour, and external inputs, including mineral fertilisers, that are considered to be most efficiently used within the context of Integrated Soil Fertility Management (Ibid.: 97-99).

TSBF-CIAT (2009) names cassava as one of the three major food crops (alongside banana and rice) with high potentials for improved soil fertility management. It further argues that there is a large gap between average farmer yields and trial yields, which implies that there is great scope for yield improvement. Their blanket recommendations are for dissemination of improved, diseased free, high yielding varieties, and following better agronomic and integrated pest (IPM) and soil management practices such as ISFM. It is argued that a combination of pests, diseases, poor cultural practices, and the lack of use of mineral fertilisers contribute to yield losses of over 50% and account for the large difference between potential and actual yields (Ibid.: 102). TSBF-CIAT acknowledges the fact that, with the exception of potassium, cassava may export fewer nutrients from the soil in comparison with cereals and therefore it is *not* a soil nutrient depleting crop as is commonly thought. The efficiency of nutrient recycling in cassava-based intercropping systems is also emphasised, especially in the case of cassava-legume intercrops that have a regenerative effect on soils. ISFM strategies that are appropriate for cassava production in the humid tropics have not yet been elaborated. TSBF-CIAT, however, argues that investments in cassava production offer huge potentials because significant gains in productivity are likely, and cassava and its intercrops are important staple food and cash crops. Efforts should be directed first at establishing fertiliser requirements and accompanying ISFM methods, which should focus on developing candidate ISFM practices and the accompanying diagnostic tools for improved fertiliser and organic resource management. This should be combined with the dissemination of improved cassava varieties that are mosaic resistant, and of dual-purpose grain legume varieties (Ibid: 104-105). The following are the resultant hypotheses that will be discussed in this chapter.

General hypothesis: The traditional agroecological systems under study are more adaptive and resilient as compared to high input monoculture systems that depend on external inputs that are generally promoted by research institutions, AGRA, and the Cameroon Government.

Sub-Hypotheses:

1. Using yields of individual crops as a measure to assess the productivity of traditional agroecological systems underestimates total productivity and undermines the contribution of the diversity of intercropping to the achievement of the multiple functions and goals of small-scale African farmers.
2. AGRA argues in very broad terms about the poor suitability of soils in Sub-Saharan Africa. It is argued that Cameroon has a range of soil types and ecologies and such soils are suitable for the crops that are grown.
3. Well-managed cassava-based polyculture systems generally have sufficient nutrients to meet farmers' needs and remain sustainable, without the use of external inputs such

as chemical fertilisers. Incorporation of chemical fertilisers into such systems represents a threat to such systems.

4.3 Methods

The research was carried out in two villages: Malende and Koudandeng. As discussed in Chapter 2, these villages fall within the tropical equatorial rainforest region but have some variation in relation to their agricultural potentials. They differ in their production systems, economies, and ethnic composition, and both have factors that provide insights into the impacts of government policy and of the process of cassava commoditisation on cassava biodiversity management and on traditional agroecological systems.

Sixty-four cassava-producing households (30 from Malende, 34 from Koudandeng) were selected for research by means of a stratified random sampling procedure. The stratified random sample was selected from the total sample of households that was censused by the researcher in 2003. Given the ethnic diversity of Malende and the varied socio-economic characteristics of farmers in both villages, which may influence cassava varietal diversity, knowledge, and livelihood strategies that are discussed in other chapters, it was necessary to ensure that farmers from various social strata were included, if complete knowledge of these domains was to be obtained. Purposefully, HIV/AIDS afflicted households and polygamous, dual headed, and single headed households were included in the sample of households. Willingness to participate in the research was an important selection criterion. In the case of dual headed households, couples were interviewed separately to avoid interference and the fear of revealing information that either men or women considered to be confidential.

Three main methods were used to collect the data: a survey, in-depth interviews, and a literature review. A household survey was used to collect data related to general farming systems and related land tenure forms, agroecology, fallow rotation systems and soil fertility management strategies, crop production, and reasons for managing polyculture fields. A survey on cassava production was used to collect data related to inputs and the related costs, and the pests and disease problems that farmers face.

In-depth (semi-structured and unstructured) interviews were carried out with selected farmers to clarify certain ideas that were not very clear in the survey data and to discuss sensitive issues. An interview guide on selected issues was prepared after scanning the survey data collected. Data related to the following issues were collected: farming systems, soil fertility management strategies and their economic rationality, crop production, reasons for managing cassava-based polyculture fields, and the functions and benefits of cassava-based polyculture systems.

Literature was reviewed to obtain information on the agroecology and aptitude of the study area for agriculture, farming systems, nutrient extraction, and requirements and nutritional values of some companion crops in a cassava-based polyculture field, as well as the value of fallow systems in relation to soil fertility.

The survey data were analysed using proportions, percentages, and frequencies. Regression analysis was done with respect to the factors that determine the lengths of fallows in the study areas. Tables and graphs were used to summarise and present more specific data. Photographs were also used to illustrate some of the important points made. Qualitative interview data were coded and analysed narratively (description, explanation, interpretation, quotations). Data obtained from existing literature were either adopted or adapted to suit the issue that was being discussed. Some of these data were used to illustrate a point.

There are several important limitations in the data. The small household sample size did not permit the use of more sophisticated statistical analyses by sub-groups within villages, which limited most of the analysis to descriptive statistics and qualitative analysis. The fact that no soil analysis of the study sites was done, the nutrient requirements of companion crops in cassava-based polyculture fields were not estimated, and no data was collected on the yields of cassava-based polyculture fields and monoculture fields of the same size and crop density presented limitations for the discussions and conclusions drawn.

4.4 Cassava-based Cropping Systems in the Study Sites

Traditional cassava-based polyculture fields are multi-layered and multi-species with complex temporal and spatial configurations, as discussed in Chapter 2. Although fields in the study area are designated by the name of the crop that has greater meaning to them, farmers in both villages grow a combination of crops in all fields. For example, in Koudandeng, a groundnut field is one in which groundnut and cassava, the crops that are the most meaningful in the daily diet, are planted in association with other major and minor crops. In Malende, a cassava field contains a combination of cassava (the main cash crop) and other major and minor crops. Tables 4.1 and 4.2 depict the types of crops that are commonly found in traditional cassava polyculture fields in the two villages. Gockowski et al. (2004) identified similar crop associations in groundnut fields (groundnut/cassava-based cropping systems) where groundnut and cassava were the main crops, while maize, cocoyam, plantain, and green leafy vegetables were other important crops.

Table 4.1 Types of Crops Grown in Groundnut-Cassava-based Polyculture Systems in Koudandeng*

Major Crops (large plant population)		*Minor Crops (small plant population)*	
Crop	*% Households Growing*	*Crop*	*% Households Growing*
Groundnuts	100.0	Okra	27.0
Cassava	100.0	Onion	20.6
Cocoyam	77.8	Egusi	11.1
Green Leafy Vegetables	69.8	Yam	7.9
Plantain	65.0	Sesame	6.3
Maize	61.9	Pepper	6.3
		Tomato	6.3
		Banana	4.8

*Soybeans, sugar cane, and berries were mentioned by one household each, and thus were considered idiosyncratic. Source: Household survey and freelisting follow-up interviews.

Table 4.2 Types of Crops Grown in Cassava-Egusi-Maize based Cropping Systems in Malende*

Major Crops (large plant population)		*Minor Crops (small plant population)*	
Crop	*% Households Growing*	*Crops*	*% Households Growing*
Cassava	100.0	Cocoyam	27.0
Egusi	75.7	Sweet yam	16.2
Maize	75.7	Water yam	10.8
Groundnut	51.3	Plantain	10.8
		Green leafy vegetables	8.1
		Colocasia (taro)	5.4
		Pepper	5.4

*Calaba yam, banana and sweet potato were mentioned by one household each and thus were considered idiosyncratic. Source: Household survey and freelisting follow-up interviews.

The different crops grown in traditional cassava-based polyculture fields are planted in myriad combinations that reflect the individual farmer's or household's nutritional, agronomic, economic, social, and cultural needs and interests. In Koudandeng, between three and 11 crops are intercropped in such fields. On average, a combination of six different major and minor crops is planted per field, and the modal number of crops per field is seven. Tables 4.3 and 4.4 depict the most common crop combinations identified in Koudandeng and Malende, respectively, presented in terms of major and minor crops.

Table 4.3 Some Common Cassava-based Polycultural Systems in Koudandeng

Order	*Major Associated Crops*	*Minor Associated Crops*
1st	Groundnut/cassava/plantain/maize/ cocoyam/green leafy vegetables	Okra
2nd	Groundnut/cassava/plantain/maize/ green leafy vegetables	Onion and/or egusi
3rd	Groundnut/cassava/cocoyam/maize/ green leafy vegetables	Egusi and/or sesame, okra
4th	Groundnut/cassava/cocoyam/maize/ plantain	Yam and/or tomato/pepper
5th	Groundnut/cassava/maize/cocoyam/ green leafy vegetables	Okra/onion
6th	Cassava	Groundnut/maize/cocoyam and/or plantain/green leafy vegetables/okra

The size and distribution of these fields in both villages is varied. They are either established in newly cleared secondary or primary forests, in cleared fallow vegetation fields, or in swamps or marshy areas (the latter in the case of Malende). Zimmerer (1999) uses the term 'overlapping patchworks' to describe a similar distribution and composition of fields in Peru and Bolivia, which is also an apt description for these study areas.

In Koudandeng, traditional groundnut/cassava fields (Figure 4.1) are women's main food crop fields and are therefore larger (0.8 ha - 3 ha; av. = 1.2 ha) than women's other food crop fields. The groundnut/cassava field is the chief source of household food security (Gockowski et al., 2004) (see also Chapter 6). Both men and women manage cassava/egusi/maize-based fields in Malende (Figure 4.2) and their sizes range from one to four ha. They rank 3rd (1.32 ha) to plantain (1.43 ha) and maize fields (1.37 ha) in average size among all the food crop fields managed in Malende. These polyculture fields are either established in newly cleared secondary or primary forests, in cleared fallow vegetation fields, or in swamps or marshy areas (in the case of Malende).

Table 4.4 Some Common Cassava-based Polycultural Systems in Malende

Order	*Major Associated Crops*	*Minor Associated Crops*
1st	Cassava/egusi/maize/groundnut	
2nd	Cassava/egusi/maize	
3rd	Cassava/egusi/maize/groundnut	Cocoyam
	Cassava/egusi/maize	
5th	Cassava/egusi/maize/groundnut	Water yam/sweet yam/pepper
6th	Cassava/egusi/maize	Plantain/sweet yam/ cocoyam
7th	Cassava/maize/groundnut	Cocoyam/plantain/colocasia
8th	Cassava/egusi/maize/groundnut	Plantain/cocoyam/green leafy vegetables

As discussed in Chapter 3, Gliessman (1990), Altieri (1995), Lok (2001), and Diehl and Howard (2008) have shown that the microenvironments of traditional polyculture fields undergo continuous development and change. Farmers seek to combine crops in these fields to achieve a balance between crop production, weed suppression, soil improvement, and nutrient balance between crops. The traditional cassava-based polyculture fields of Malende and Koudandeng are structured such that the spatial and temporal distributions and configuration of crops vary over time according to specific ecological processes and principles. The spatial and temporal co-occurrence of the different crops and varieties exhibit shared environmental requirements and ecological interference, which reflects the ways in which farmers consider and combine aspects of crop autoecology and synecology.

The vertical structure is such that creeping crops (egusi) and small or short crops, such as groundnuts and colocasia, form the understory, while medium-height crops, such as short branching cassava varieties, cocoyam, maize, and some green leafy vegetables, occupy the middle part of the structure, and tall crops, such as tall branching cassava varieties, okra, plantain/banana, and, at times, trees, form the apex. The horizontal structure consists of at least six to seven crops that are combined to facilitate ecological processes such as nutrient recycling, facilitation, and complementarity, and to reduce competition among intercrops.

Intercropping cassava with short cycle crops (especially groundnut and egusi) also facilitates weed control for cassava, since these crops require weeding at very early stages (one month after planting). Weeds are also removed during groundnut harvest. According to farmers, egusi vines creep rapidly and thus cover most of the soil surface that would have been occupied by weeds (or 'grass', as weeds are commonly called). Common sayings among Koudandeng and Malende farmers are: "Egusi and groundnut kill grass which lightens our burden of weeding our cassava fields." "Egusi is a creeping crop that covers the soil and prevents the growth of grass." "Groundnuts require weeding at one month after planting and, if not weeded at this age, the harvest is lost and one loses the crop season. Weeding is also done during groundnut harvest, after which cassava is left to grow and the last weeding is done after four months when the cassava crop is seven months old."

Figure 4.1 Groundnut/Cassava-based Polycultural Fields in Koudandeng

a) A newly established field (3-4 weeks old)

b) A much older field

Figure 4.2 Cassava/Egusi/Maize Based Polyculture Fields in Malende

a) 7 week old field

b) 7 month old field (egusi, maize, groundnut already harvested)

Other scholars (Kumar et al., 1987; Alabi and Esobhawan, 2006) have observed the ability of companion crops to reduce the spread of weeds. Leihner (1983) found for cassava that the earliest growth stages (until canopy formation, four months after planting) are the most critical for weed control, which is a pre-condition for high productivity.

4.5 Estimating Yields in Polyculture Systems and Yields in the Study Site

The hypothesis put forth here is that using yields of individual crops as a measure to assess the productivity of traditional polyculture systems underestimates total productivity and underestimate the contribution of polyculture to the achievement of the multiple goals of small-scale African farmers. Here and elsewhere in this dissertation, it is argued that small-scale African farmers' main objective is to ensure sustainable livelihoods rather than to increase productivity and maximise profitability on the basis of specific crops. AGRA refers to low productivity in relation to cereal yields, but measuring the yields of single crop species is inappropriate in circumstances where a diversity of crops is intercropped. Rather, aggregate yields (of all the intercrops for a given period in time in a given space) should be used to assess the productivity of polyculture systems as well as the services that these render to farmers (fuelwood, labour saving, dietary diversity, cultural and spiritual values, etc.).

It is argued that the overall output of food per unit land area throughout the year in cassava-based polyculture systems is higher than what it would be in monoculture, and the additional services rendered to farmers in polyculture systems are also important. On average, seven different crops are combined in a cassava polyculture field in the study area. Different crop combinations per field are determined by farmer's objective of maximising total output rather than maximising yields of individual crops. Rather than evaluating the performance of cassava-based polyculture fields based on the performance of cassava that is grown in monoculture, the Land Equivalent Ratio (LER) provides a superior alternative, since it refers to the land area that is required to produce the same amount of each companion crop yield in monoculture as is produced on a unit of land in polyculture (Vandermeer, 1989; Mead and Willey, 1980) using the same plant population (Altieri, 1995).

Vandermeer (1989) criticises the fact that most agronomic and practical applications use optimal monocultures (producing the highest yields) to compare and assess the performance of polyculture fields. Given the difficulties of estimating total output of companion crops in a polyculture field, researchers often use reference crops while neglecting other companion crops. However, it is uncertain which crops should be used as reference crops. Which criteria should researchers use to determine the economic and food importance of the reference crops? Should the reference crops be named by farmers or by researchers? For example, Numbem (1998), in his study of the soil productivity potential of indigenous groundnut-based cropping systems in Southern Cameroon, used cassava, maize, and groundnut as the reference crops, since these are of economic and food value importance. He noted that, because these crops are planted in association with other crops, the yields presented were only a partial indication of the actual performance of the system (Ibid: 107). Limiting the criteria for the choice of reference crops to economic and food value may under-estimate the importance of other criteria that are very meaningful to farmers, such as gift giving, and using reference crops at all underestimates the importance of companion crops that are also meaningful enough for farmers to cultivate them at all. Table 4.5 highlights the fact that using reference crops leads to only a partial evaluation of the output of polyculture fields.

Malende and Koudandeng farmers obtain higher yields in the various cassava-based polyculture fields than they would obtain from an equivalent area that is sown in patches of monoculture while respecting the same plant density. If farmers have to obtain the same total yield as that obtained in one ha of groundnut/cassava/maize-based polyculture field, then they would have to mange on average seven to eight different fields of one ha each sown in monoculture with the same planting density for each companion crop. This study did not set out to investigate the yield of each component crop when planted in monoculture fields using the same planting density, so the LER for farmers' cassava-based polyculture fields could not be calculated.

Aggregate crop yields are of interest and importance to farmers. Table 4.5 depicts an aggregate output of companion crops in a cassava-based polyculture field in Koudandeng. Actual measurements of total annual output were not attempted. Due to the difficulties involved in standardising farmers' varied measures of outputs, the case of Gertrude, a female farmer, is presented. The figures are an estimation based on the discussion held with Gertrude.

Table 4.5 Aggregate Yields of Companion Crops in a 1 Ha Female Farmer's Field in Koudaneng

Crop	*Months after planting to maturation*	*Yield Characteristics*					*Length of harvest*	*Total yield (kg)*
		Harvest for consumption per week		*Harvest for sale per month*		*Gifts*		
		No. times	*Qty (fresh weight)*	*No. times*	*Qty (fresh weight)*	*Qty (fresh weight)*		
Green leafy vegetables	2 mos	2	2 bundles of about 500g ea per harvest	2	20 bundles of 500g ea	5 bundles of 500g ea	1-2 mos	58.5
Okra	3-4 mos	1	1 x 3 litre bucket	1	2 buckets of 15 litres ea	1 bucket of 5 litres ea	2-3 mos	85.4 to 125.8
Cassava leaves	4-6 mos for a thick canopy	4 if abundant (rainy season) 2 when scarce	2 bundles of about 500g ea per harvest	1	40 bundles of about 500g when abundant 10 bundles when scare (dry season)		3-6 mos depending on variety	151 to 294
Cassava Roots	12-18 mos (6-8 mos for early maturing varieties)	4	1 bag of 15 kg per harvest	2	3 bags of 50 kg each per harvest	-	9 (all varieties combined)	5310
Cocoyam	12 mos	1 in 2 weeks)	1 bag of 15 kg	1 per yr	1 bag of 100 kg per yr	-	3-5 yrs	1380 to 2300
Groundnut	3 mos		3 bags of 100kg dry weight unshelled (total harvest)	-	-	1 x 15 litre bucket	2-3 wks	314.4
Maize	3 mos	6	1 bucket of 15 litres fresh weight (with shells) per harvest		3-4 bags of 50 kg dry weight (total harvest)	2 x 15 litre buckets	1 month	398.8 to 588.8

Table 4.5 Aggregate Yields of Companion Crops in a 1 Ha Female Farmer's Field in Koudandeng (con't).								
Plantain	12 mos	1 per mo	2 bunches of 15 to 20kg	1	5 bunches of 15 to 20 kg (during peak production periods = 6 mos/yr)	2 bunches of 15 to 20 kg per 6 mos	3-5 yrs (2-3.5 yrs maximum yield)	2400 to 3800
Banana	12 mos	1 per mo	2 bunches of 5 to 10 kg	1	5 bunches of 10 kg each (during peak production periods = 6 mos /yr)	6 bunches X 10kg per 6 mos	3-5 yrs	720 to 1140
Total yield overall in kilograms: 10818.1 to 13931.5								

*Local measures: distance between two electric poles = 50m²; * 1litre container of food item weighs 0.96kg. Source: Household survey and interview.

The aggregate crop yield in Gertrude's field, of between 10.8 t/ha to 13.9 t/ha, is substantially higher than the average 8.8t/ha that cassava would yield when planted in monoculture in Africa under farmers' field conditions as reported by TSBF-CIAT (2009: 101).

It should be noted that green leafy vegetables, okra pods, and cassava leaves and roots are harvested progressively while allowing for regrowth and new root bulking. During the first cassava harvest period, farmers practice what is called "root tapping". Mature cassava roots are partially removed while leaving the stem standing, and the ground is covered to enable new roots to bulk. Piecemeal harvesting increases total yield compared to harvesting crops all at once.

To estimate the productivity of fields, the estimation of aggregate yield should consider all of the companion crops that are planted in a polyculture field. Guyer's (1977) study of a women's farming system in Lekie Division (to which Koudandeng belongs) provides an example of a partial estimation of the aggregate yields of a cassava-based polyculture field. She reported that the total yield per crop of a 10 acre groundnut-based polyculture field was 160-240 kg of groundnut, 3000 kg of cassava, 1000 kg of cocoyam, and 140 kg of maize grain, while plantain yield depended on planting density (Ibid.: 57). Considering that an acre is 0.4047 ha, then one ha of a Lekie woman's groundnut-based cassava field in 1977 produced between 1027.9 kg/ha and 1047.7 kg of three crops, whereas the polyculture field contains on average six to seven crops. While this confirms the fact that farmers are more interested in total output rather than maximising the yield of individual crops, the data is limited to reference crops of economic importance, and is thus a partial estimation of the aggregate output of a Lekie woman's groundnut-cassava-based field since not all crops were included.

In order to assess the biases that arise when reference crops in cassava-based polyculture systems are used to quantify yields rather than total output as is discussed in the literature (Numbem, 1998; Leihner, 1983), the results of an analysis of the survey data on the yields of what farmers perceive are the most meaningful crops is presented in Table 4.6. The data were collected based on recall and it must be remembered that farmers may under-report the amounts harvested for fear of tax obligations. The data in Table 4.6 are only partial estimates of the performance of traditional Koudandeng cassava-based polyculture fields, since not all crops are included.

Table 4.6 Yields of the Two Most Meaningful Companion Crops (per ha) in a Cassava-based Polyculture System in Koudandeng

Companion Crop	*Total yield range (kg/ ha)*	*% Farmers involved*	*Average yield per ha*	*Median yield per ha*	*Mode yield/ha*
Cassava	3000-4375	25.9	6146	5880	4960
	4376-5880	48.2			
	5881-9900	25.9			
Groundnut	78-200	44.4	297	300	200
	201-300	27.8			
	301-600	27.8			

It can be concluded that farmers' interests are to maximise total output rather than to maximise the yield and profitability of individual crops, and therefore they grow a diversity of crops in polyculture fields. These crops are harvested piecemeal according to farmers' individual needs and priorities. The aggregate yields (overall output) of all the companion crops in polyculture fields are higher than the yields of individual crops when grown in monoculture using the same planting density per unit area of land. Researchers often underestimate the performance or productivity of farmers' polyculture fields when using reference crops in their evaluations, or when comparing the partial yields of polyculture fields with the yields of individual crops that are grown in high potential areas, such as researchers' fields.

A comparison of the yield data obtained in tables 4.5 and 4.6 highlights the fact that using the yields of one or two reference crops to evaluate the performance of Malende and Koudandeng traditional cassava-based polyculture systems leads to incorrect policy recommendations since these are partial results that are nevertheless not interpreted as partial. Moreover, farmers' evaluation criteria for their polyculture fields are not limited to the performance of one or two crops, but rather refer to all of the companion crops. The land equivalent ratio (LER) should be used to evaluate the performance of polyculture fields relative to monoculture fields, which will avoid incorrect judgements and incorrect and counter-productive policy recommendations.

4.6 Soils of the Study Area and their Suitability for Agriculture

One of the main reasons that AGRA promotes fertiliser use across Africa is that it argues that traditional African farming systems are unsustainable because soils are naturally poor. Here it is argued that Cameroon has a range of soil types and ecologies and that the soils in the study sites and their respective regions are suitable for the crops that are grown. While soil analysis was not carried out in this study, the information presented here is adopted from a description of the characteristics of the soil types according to the FAO, UNESCO, and USDA classification systems, as well as other studies carried out in neighbouring areas.

4.6.1 Koudandeng

As discussed in Chapter 2, the soils of Koudandeng represent a combination of haplic ferralsols (Yerima, 1998). They are also considered to be of the rhodic kandiudult type (Gockowski et al., 2004; Madong à Birang, 2004) and contain some alluvial soils since they lie within the Sanaga River Basin (Gockowski et al., 2004).

These soils have good physical properties. Koudandeng soils are well drained and their available water storage capacity is medium. They are deep, highly permeable, and have a stable microstructure and are therefore less susceptible to erosion. Their consistency is friable and slightly sticky, which makes them easy to work by hand with the hoe. They have a reddish brown or dark red colour. Some areas have dark colour soils.

Gockowski et al. (2004), in their analysis of the Yaounde block (Nkometou II, a village neighbouring Koudandeng included) of the Cameroon Congo Basin Bench March sites, presented the chemical composition found in Table 4.7. These analyses show that the soils are of medium fertility, which is affirmed by Yerima (1998: 81) when he recounts that, among all the ferrasols soil types, haplic ferrasols are moderately good for arable farming.

Table 4.7 Top Soil Parameters of Nkometou II

Soil Depth	*USDA Soil Type*	*Soil Parameters*						
		Clay (%)	*OM (%)*	*pH*	*Ca meq/100g⁻¹*	*Mg meq/100g⁻¹*	*K meq/100g⁻¹*	*CEC*
0-15 cm	Phodic Kandiutult	31	2.5	5.2	2.6	1.0	0.1	3.7
50-60 cm		60	0.3	5.0	0.4	0.4	0.0	1.4

Source: Adapted from Gockoswki et al., 2004.

A characteristic of most ferrasols is the strong inactivation of phosphorus and the low cation exchange capacity (CEC) as a result of the loss of organic matter or clay particles and the leaching of most water soluble minerals (K, NA, Ca, Mg and Si). However, this analysis shows that the CEC of Nkometou soils and its environs (therefore Koudandeng) is moderate. This implies that the rate of loss of soil organic matter, clay particles, and water-soluble minerals through leaching is moderate relative to other ferrasols. Also, the soil acidity (pH) level is > 5, implying that aluminium (Al) toxicity does not occur and is therefore not a major problem for crop production in this vicinity (a pH level of 4.5-5 favours aluminium toxicity) (Ibid.). This also implies that the CO_2 concentration (from respiration by roots and soil organisms feeding on organic matter) in Koudandeng soils is not too low. The process of ferralitisation (advanced stages of hydrolysis of the parent materials/rocks) is slower in these soils due to the higher pH level compared to ferrasols that have low pH levels and a higher level of ferralitisation. This may be due to the fact that the parent materials of Koudandeng soils are a combination of basal and acidic rocks: 2-mica micaschists, granite, kyanite or cyanite-mineral aluminium silicate $A_2SiO_{5)}$, staurotide, quartz, igneous, mica (silicate) and magmata. Pedologically, soils of acidic parent material experience a slower process of ferralitisation relative to soils of basal parent material and the reverse is true for the silica content of the soil solution.

An analysis of the chemical composition of haplic ferrasols in the Ketambo to Fonfukka area in the Northwest Province of Cameroon shows that, at a soil depth of 0 to 25 cm, 100g of soil contains 2.35 meq of organic carbon content (Org. C), 0.18 of total nitrogen

(N), a C/N ratio of 13 and an average phosphorus content of 3 (Ibid.). This implies that, although ferrasols have major problems with phosphorus fixation, there is still some amount of phosphorus available at the root zone in haplic ferrasols.

Average annual soil temperature in Koudandeng ranges from 24-25˚C, soil moisture content is high, and the soils are not dry for 90 cumulative days in a year (udic moisture regime). With regard to overall crop environment, Yerima (1998), Gockowski et al. (2004) and Yerima and van Ranst (2005) show that haplic ferrasols are suitable for the production of oil palm, cocoa, robusta coffee, cassava, groundnut, maize, cocoyam, yam, sweet potato, plantain, and tropical vegetables. These soils fall within the 1.8 million ha cassava belt of Humid Tropical Africa TSBF-CIAT (2009). The chemical composition, the amount of vegetation cover, and agroclimatic conditions such as soil temperature and moisture conditions, precipitation, and solar radiation, determine the agricultural potentials of an environment. The medium fertility level of Koudandeng soils, their good soil temperature and moisture conditions, the high precipitation level and pattern of bimodal rainfall, high solar radiation, and moderate relative humidity provide a good environment for the production not only of cassava, but as well of several other annual and perennial crops. They provide a favourable environment for plant photosynthesis and therefore a high probability of crop establishment and growth.

The soil chemical composition indicated above highlights the fact that the bulk of all available plant nutrients in the Koudandeng soils is concentrated in the upper 0-50 cm, which corresponds to the root zone for nutrient uptake. This does not present any problem in the practice of shifting cultivation with fallow rotation systems because of nutrient recycling through plant debris. Cassava has been proven to have a regenerative effect on soils through the nutrient recycling of its leaf biomass and litter, which replenishes the nutrients lost during plant growth and harvest. Cassava roots also go beyond the root zone and therefore easily access phosphorus that is not readily available at higher levels of the topsoil. Moreover, cassava and other intercrops can tolerate low levels of acidity and CEC.

4.6.2 Malende

As indicated in Chapter 2, Malende soils are fluvisols that also have deposits of andosols as a result of runoff plant debris and minerals from Mount Cameroon. Malende's soils have good physical properties: a dark or dark grey colour, sandy clay loam, friable soil, are slightly sticky and plastic and thus are easy to work with the hoe. They have fine pores and roots and other plant debris are common. Water holding capacity is high and soils are moderately (not well) drained; some areas are poorly drained (marshy).

Yerima's (1998) analysis of similar fluvisols located along the Wum-Bafut road near Obang village in Cameroon showed the following characteristics: 23.9% clay content, 27.8% silt, and 48.3% sand at a depth of 0-10cm. Malende's mean annual soil temperature is about 28˚C and its soil moisture content ranges between 6.4 to 6.7% (Table 4.6).

Malende's soils consist of average size white sandstones that are rich in feldspar, quartz, and carbonate; sandy clays that are interspersed with sand; poorly consolidated sandstone; and stratified dark colour mica-silt-clay (fine grain sediments of mud and clay particles) that are layered and rich in organic matter (plant and lignite-brown coal). An analysis of composite soil samples of four plots in Yoke (IRAD farm < 1 km away from Malende) by the Institute of Agronomic Research for Development (IRAD) Ekona in 1982 reported the chemical composition found in Table 4.8.

Table 4.8 Chemical Composition of Yoke-Malende Soils

Chemical Elements	*Plot A Traditional land clearing and management*	*Plot B Traditional land clearing and management*	*Plot C Traditional land clearing, no burning but removal of stumps*	*Plot D Manual land clearing, removal of stumps, tractor ploughing*
Org. C %	1.03	0.92	0.79	1.04
Total N %	0.12	0.11	0.12	0.13
C/N ratio	8.5	8.4	6.6	8.0
Av. P (Bray II)	9	8	5	6
Moisture %	6.5	7.2	6.4	6.7
pH H_2O 1:2.5	5.7	5.9	5.4	5.6
pH Kcl 1:1	5.3	5.5	5.1	5.3
CEC (meq/100g)	6.53	6.15	6.07	7.22
K^+	0.06	0.07	0.05	0.06
Na^+	0.00	0.00	0.02	0.00
Ca^{++}	2.48	1.91	1.39	1.85
Mg^{++}	1.94	2.00	1.48	1.85
TEB	4.77	4.19	2.93	3.76
BS %	68.6	68.1	48.0	52.1

Source: IRA-CRA, 1982.

The authors highlight the fact that burning during land preparation increases the availability of soil phosphorus, exchangeable calcium, and magnesium, as well as the pH level and base saturation of these soils (IRAD, 1982: 134). This analysis confirms Yerima's (1998) report that fluvisols are fertile soils that have neutral or near neutral pH values that do not impair the availability of nutrients. The contribution of soil organic matter to the cation exchange capacity (CEC) is moderate, which favours plant development.

These soils are classified among the most fertile for agriculture because the constant deposition of debris from runoff water gives these soils a thick organic matter structure and biomass that facilitate the cycling of plant nutrients such as nitrogen and phosphorus, and large proportions of base nutrients such as potassium, calcium, and magnesium.

Regarding overall crop environment, Malende soils, just like those of Koudandeng, fall within the 1.8 million ha cassava belt of Humid Tropical Africa (TSBF-CIAT, 2009). Their generally rich chemical composition, good physical properties, and favourable agro-climatic conditions such as soil temperature and moisture conditions, precipitation, and solar radiation, as well as high vegetation cover, provide favourable environments for not only root and tuber crop-based cropping systems, but also for perennial and industrial tree crops. Yerima (1998) indicates that these soils are good for the production of cocoyam, yam, cassava, taro, tropical vegetables, rubber, oil palm, and banana and, to a lesser extent, cocoa. Robusta coffee and tea are grown at higher elevations. Groundnut and maize are also of relative importance here. Every farming household in Malende grows cassava.

Kendi (2002), in his analysis of the challenges to the modernisation of food production using improved technologies in Muyuka (Malende inclusive) Cameroon, stipulated the following conditions as ideal for cassava production: i) a temperature range of 24˚C-35˚C, ii) an average minimum annual rainfall of 600 mm; and iii) loamy, deep, well drained and plant nutrient rich soils with high water holding capacity. Koudandeng and Malende soils correspond to most if not all of these conditions and this explains in part why all farm households in these villages grow cassava.

In conclusion, Malende and Koudandeng soils have good physical properties and medium to rich chemical composition, favourable relief, high vegetation cover, and good agroclimatic conditions that determine their high agricultural potentials, and thus are suitable for growing both perennial and annual crops. These soils cannot be considered as poor. Furthermore, all of the factors that determine the agricultural potentials of an environment should be considered as a whole when making agricultural suitability judgements and soil fertility improvement recommendations. The argument that African soils are naturally poor and are mined emphasises the chemical composition and physical properties of soils, while neglecting other factors such as the agroclimatic conditions (temperature, rainfall and precipitation, soil temperature and moisture conditions, solar radiation, and the mount of vegetation cover).

4.7 Nutrient Management

The Cameroon Government, AGRA, and regional research institutes associate the supposed decline in per capita crop yields in Africa to the lack of sustainability of traditional African farming systems due to the fact that soils are mined and few or no chemical fertilisers are used. This assumption is contested here in relation to farmers' soil nutrient management strategies in polyculture fields.

The hypothesis is that well-managed cassava-based polyculture systems generally have sufficient nutrients to meet farmers' needs and remain sustainable without the use of chemical fertilisers. AGRA's assumption that the length of fallows is becoming shorter, thus leading to nutrient deficient soils, may not be true. The assumption that shortened fallows are insufficient to regenerate soil fertility is not true. It is argued that farmers' soil fertility management strategies are adapted to and adapt agroecological conditions using natural processes and inputs to maintain soil fertility. These include (a) the association of different crops to achieve optimum nutrient management, (b) the slash-and-burn method of land preparation and fallow rotation systems, (c) the evaluation of soil fertility through vegetation cover, and (d) the management of the landscape through the spatial distribution of crops in time and the use of microsite niches.

4.7.1 Crop Associations and Nutrient Management

4.7.1.1 Spatial and temporal crop distribution

Apart from associating nitrogen fixing and non-nitrogen fixing crops to obtain optimum nutrient management in cassava-based polyculture fields (discussed later in this section), farmers' landscape management strategies are such that the spatial and temporal distribution of companion crops reduces nutrient competition.

The physical layout of crops in a cassava-based polycultural system is designed to avoid or reduce competition among crops. For example, some Malende farmers indicated that, during planting, tall branching cassava varieties are planted closer to broad-leafed crops to avoid interference during the period of crop establishment. In the case of cassava, where phenotypic traits such as vigour and branching habit (leafiness) are major determinants of suitability in intercropping, varieties with an erect growth habit (late branching) and medium vigour possibly produce less shade for an intercrop (less competition and thus higher yields) in comparison with those varieties that are early branching with high initial vigour. Colocasia and cocoyam are planted closer to tall plant populations such as plantain because, according to farmers, these crops have complementary nutrient requirements. Some Malende farmers explained that plantain produces a substance that makes cassava roots bitter (high cyanide content); as such, these two crops are not planted close to each other. This phenomenon, which is yet to be investigated, may represent allelopathy, where plantain produces some allelochemicals that increase the cyanide content of cassava roots. This may explain why plantain is not planted as a major crop in cassava-egusi-maize based cropping systems in Malende. When plantain is planted as one of the major crops in the groundnut-cassava-based system in some Koudandeng fields, cassava is not planted close to plantain. Most often, plantain fields are separated from cassava-based polycultural fields in both villages.

4.7.1.2 Soil erosion and nutrient loss reduction

In relation to facilitation and successional changes, the spatial distribution of the crops is designed to maximise the efficient use of water and light, as well as nutrient resources, and to check against soil erosion and nutrient loss. For example, understory crops such as egusi and groundnuts have a short growth cycle spurt, spreading rapidly after planting and covering the soil surface, thus reducing the rate of exposure of stopsoil to heavy rain and/or high solar radiation.

In Malende, egusi is planted as the first crop immediately after land preparation in February, while cassava and all other intercrops are planted at the onset of the rains (mid-March till April) after egusi has sprouted. The egusi vines spread rapidly and cover the soil, thus reducing the rate of water evaporation from the soil, especially from mid-March to April when the atmosphere is clear (no haze or hamattan covering) and the relatively high solar radiation hits the soil directly. The same principle applies in the case of Koudandeng where, at the onset of the rains, groundnuts are either planted two weeks before cassava and other companion crops or at the same time.

Groundnut and egusi soil coverage modifies the soil environment by helping to maintain soil moisture and lowering soil temperature to levels that permit sprouting and establishment of other intercrops. During the peak of the rainy season(s) (May-June and September to mid-October), the fully established groundnut and/or egusi plants protect the soil from heavy rains and thus reduce the rate of soil nutrient leaching and erosion.

Numbem (1998) reported that the groundnut-based cropping system of Southern Cameroon requires a clean-tilled surface, which is easily eroded by intense rains, leading to rapid degradation of soil productivity. This statement is contested by the findings of this research, in that it takes about one month (40 days) after planting for groundnuts to cover the soil surface, during which time the rains are not intense. Moreover, Numbem (1998), citing Sanchez (1976), further argues that a major pathway for fertility loss in the groundnut-based fallow system is leaching of basic cations from heavy rains on unprotected soils such as where groundnuts are grown; it is argued here that, when the soil surface is exposed only briefly, such erosion is minimal.

Apart from the soil cover function of groundnut, this crop is shade intolerant and requires a clean tilled-ground surface in order to establish itself. However, the period of full establishment after planting of groundnut and egusi is short and corresponds to the period when other intercrops are still sprouting, which does not affect their productivity and that of companion crops.

4.7.1.3 Companion crops and nutrient competition

Farmers' choice of crop combinations permits facilitation of nutrient uptake and reduces competition for nutrients among component crops. Crops that compete for the same kind of nutrients are not planted together; crops that tolerate each other are planted closer to each other; and high nutrient demanding crops are planted in specific micro-sites in polyculture cassava fields. For example, a discussion with Gertrude, a Koudandeng farmer, demonstrates her understanding that groundnut enriches the soil and thus facilitates the growth of cassava:

> In Koudandeng, the practice of crop association in groundnut fields (*afub owono*) exists since the time of our foreparents. We must always grow groundnuts and cassava together because groundnut improves the fertility of the soil for cassava, which is a heavy feeder and depletes the soil. Yam, just like cassava, grows downward and so competes with cassava for nutrients. When these two crops are planted close to each other, they do not do well. Plantain, yam, and cocoyam require more food to grow than cassava and so are often planted around decaying tree trunks. Okra, egusi, onion, pepper, and other green leafy vegetables also require special sites such as burned tree trunks and branches that have enough ash. Beans rot a lot when planted in association with cassava and other crops and so are planted in separate fields.

In farmers' understanding, differences in nutritional requirements and absorption efficiency create competition for nutrients between companion crops in a crop association. For example, cassava and egusi or groundnuts are planted close to each other because the level of competition for nutrients between these is minimal and cassava benefits from the soil fertility improvement ability (nitrogen fixation, biomass production) of egusi and groundnut.

This minimal competition may be due to the stratification pattern of the root systems of these companion crops. Leihner (1983) argued that, in a crop association, competition for mobile nutrients occurs when the absorption zone of companion crops overlap. However, this competition is reduced because root systems of companion crops barely overlap as a result of root antagonism and the tendency for growing roots to avoid moisture depleted zones. The stratification of the root system (expansion of roots to different soil depths) of these companion crops also helps to reduce nutrient competition.

4.7.1.4 Maturation period, nutrient competition, and space

The spatial and temporal combination of short and long growth cycle crops facilitates the process of nutrient management in a cassava-based polyculture system. Harvesting short cycle crops creates space for the full establishment of long cycle crops as well as reducing the level of competition for some nutrients, if this occurs at all during their co-existence. For example, maize, groundnuts, and green leafy vegetables are harvested three months after planting, while cassava and other crops are left to mature and are harvested progressively according to household subsistence needs. The harvest of green leafy vegetables is done piecemeal according to the rate of regrowth of cut stems, a process that often lasts from one to two months. Egusi is harvested from four to six months after planting. While the short cycle crops are harvested, broad-leafed intercrops such as plantain, cocoyam, and colocasia provide shade for the young cassava plants if they are planted closely together. In most cases, broad-leafed intercrops are spaced out, especially in Malende where it is believed that cassava becomes bitter if planted close to plantain.

The soil nutrient facilitation role of the grain legume/cassava association where legumes such as groundnut fix nitrogen as well as the ready colonisation of cassava's fibrous roots by vesicular-arbuscular (VA) mycorrhizae that facilitate cassava's phosphorus uptake has been cited in the literature (Leihner, 1983).

4.7.1.5 Similar soil conditions

Vandermeer (1989) argues that, while a plant lives according to the dictates of its local environment, it is an important participant in effecting change in that local environment, and thus directly influences its neighbours by changing their environment either through addition or subtraction or by exerting indirect effects on environmental conditions such as temperature, wind, and shade. What this means is that, even though Malende and Koudandeng soils are suitable for growing specific crops, these crops also influence the environmental conditions that are suitable for the growth of other crops. Along these lines, farmers associate crops in polyculture systems that can tolerate similar soil conditions. For example, cassava tolerates low levels of soil acidity, aluminium, and magnesium toxicity, and infertile soils. Leihner (1983) found that, in Colombian farmers' fields, cowpea, and groundnut showed outstanding adaptation to the soil conditions to which cassava was tolerant, and are suitable for simultaneous intercropping with cassava. She proposes that crop associations should be based on the component crops' ability to adapt to similar soil conditions.

4.7.1.6 Cropping density

The level of nutrient extraction of each crop component in a polyculture system is lower than if it were grown in monoculture because the cropping density of each component crop is reduced compared to monoculture crops, which in turn leads to lower individual crop yields.

Farmers experiment with and know the quantity of each crop to plant in polyculture systems. A discussion with some women farmers in Koudandeng showed that, in a crop association, the cropping density that would be achieved if cassava were planted in monoculture is reduced to allow for the planting of all associated crops. In their logic, in a groundnut/cassava-based polyculture field, groundnut and cassava occupy the greatest proportion of the field (about 65%), whereas the other associated crops occupy 35%. Factors such as the importance of the crop to household subsistence, income earning possibilities, the agroecological requirements of individual component crops, the capacity of the crop to suppress weeds, and the cultural and spiritual importance of the crop, among other factors, determine cropping density. Numbem (1998) found that cropping density, among other factors, influences maize and cassava production in Southern Cameroon. He reported that, in polycultures where more than 10 crops are planted at the same time, plants must be set wide apart for physiological reasons.

4.7.1.7 Crop successions

Farmers manage their polyculture fields to ensure a succession of crops over time. This temporal combination of short- and long-growth cycle annual and perennial tree crops facilitates nutrient replenishment in a cassava-based polyculture system. For example, when annual crops are harvested from a field that contains cassava, groundnut, plantain, maize, cocoyam, vegetables and some fruit trees, the cocoyam, plantain and fruit trees remain and are harvested progressively until the field is left to fallow. The fallow fields still contain some dwindling cocoyam and plantain crop populations as well as permanent tree crops. While tree roots extract nutrients beyond the root zone and make them available to the topsoil through their leaves, the above-ground parts of plantain and cocoyam are returned into the soil as biomass. The biomass thus obtained, the new vegetation cover and tree leaves that are returned to the soil improve the fertility of these fallow fields.

4.7.1.8 Optimum nutrient management strategies

As indicated above, farmers’ crop association strategies enable the achievement of optimum nutrient management in polyculture fields. These strategies include: i) planting nitrogen-fixing and non-nitrogen-fixing crops together, ii) efficient management of landscapes through the spatial and temporal distribution of crops to reduce nutrient competition; iii) using the spatial distribution of crops in any given period to maximise the efficient use of water and light resources, modify the crop environment to facilitate the growth of companion crops, and reduce the rate of nutrient loss through leaching and erosion; iv) choosing crops in accordance with differences in nutritional requirements and absorption efficiency to reduce competition for nutrients and facilitate nutrient uptake; v) planting individual crops to adapt to specific soil conditions, and growing crops in association that tolerate similar soil conditions; vi) growing long and short cycle crops to facilitate nutrient management; and vii) adjusting the cropping density of each crop grown in association (where the density of a given crop is often much lower than if planted in monoculture). Lower crop density also reduces the amount of nutrient extraction by individual crops. These strategies combined lead to well-managed polyculture fields that have sufficient nutrients to meet farmers’ needs and remain sustainable without the use of external inputs such as chemical fertilisers.

4.7.2 Slash-and-burn Fallows

The hypothesis that guides this part of the discussion on soil nutrient management counters conventional wisdom, which assumes that shortened fallow periods are a main cause of soil infertility and declining crop yields, and which has led to the promotion of fertiliser use as a principle recommendation for crop improvement. Here, it is argued that short fallow fields are not actually poor in chemical and physical properties, as purported.

Ignorance about the shortened fallow-profitability relationship (Ngobo, 2002) in cassava polyculture systems has led to the assumptions about low soil fertility and declining yields and the promotion of fertiliser use by the Cameroon Government, national and international research institutions, and AGRA. A discussion with some 40 to 75 year-old farmers in Malende and Koudandeng indicated that, in their youths, fallow periods were 10 years or more. Despite the fact that fallows have shortened to between two to three years in Malende and two to six years in Koudandeng, the shift in the type and diversity of fallow vegetation cover has modified soil characteristics and maintained or improve the fertility of these soils. Ickowitz (2004) also argued that, in Eastern Cameroon, reduced fallow length does not necessarily imply a 'breakdown' in soil fertility.

Numbem (1998), citing Sanchez (1976) and Ruthernburg (1980), argued that the basic concept and rationale behind swidden cultivation and slash and burn agriculture is to manage soil fertility by managing vegetation. Shifting cultivation is the traditional practice for the appropriation of land for the growing of crops. Slash-and-burn fields are allowed to fallow after a few years of cultivation as a means to regenerate and improve the fertility of fields.

Traditional polyculture and monoculture fields in both villages are established using the traditional slash-and-burn method, where forest (secondary, primary) and fallow vegetation are cleared. Felled trees and bushes are left for a few weeks to dry before burning. During burning, tree branches are collected around large tree trunks to facilitate the burn since trunks are often still very wet. Burning increases the availability of phosphorus, exchangeable calcium and magnesium, and the pH and base saturation levels of soils (IRAD, 1982: 134).

Uneven burning leaves ash patches. Koudandeng and Malende farmers know that these ash patches and their surroundings contain high levels of nutrients, and therefore use them to plant green leafy vegetables, okra, tomato, onion, and pepper, which are nutrient demanding crops. Numbem (1998) indicated that, in Southern Cameroon, soil fertility management in fallow systems depends heavily on the contribution of ash to the soil from flash burning and on slow decomposition of the remaining biomass, where farmers practice preferential placement of crops according to their specific nutrient requirements. He reported that southern Cameroonian farmers take advantage of micro-sites, such as areas with abundant ash, to plant vegetables that are nutrient demanding, planting plantains and cocoyam in hollows of decaying tree trunks in their groundnut based fields (afub owondo). Farmers' understanding of the fertility of the microsites in their polyculture fields is confirmed by the fact that burnt biomass and litter releases a stock of nutrients (cations: Ca, Mg, K, and Na, as well as P) in ash which increases soil pH, the amount of basic cations, and the level of cation exchange capacity (CEC) of the soil. Cassava and deep rooted trees appropriate and accumulate soil basic cations (Ca, Mg, K, and Na) and phosphorus (P) from soil depths into vegetal biomass, and these nutrients are released through burning and slow decay when the trees are cut and burnt for cultivation. Brady (1990) refers to this as maintaining soil fertility through the fertility economy of trees. The P supplied by burned biomass compensates that which is exported through harvest.

The incomplete burning of wet tree trunks and stumps and vegetation has little effect on soil organic matter content, thus less nitrogen, carbon, and sulphur are volatised as is always expected (Numbem, 1998). Climbing crops such as yam and egusi melon are planted around unburned shrubs for support, whereas hollow crevasses of decaying tree stumps provide niches for cocoyam, colocasia, and plantain.

Farmers practice selective weeding by cutting back, but not uprooting, herbaceous plants and shrubs and, once crops are harvested, these become part of the succession. Also, valuable trees (medicinals, spices) are not felled, and their deep root systems extract nutrients such as phosphorus from areas below crops' root zones, as well as making them available through leaf litter. Farmers also plant cover crops and legume trees to improve soil fertility in Malende. Legume trees are planted in Nkolfeb (a village neighbouring Koudandeng), but the labour constraints involved in pruning limits Koudandeng farmers' willingness to accept this method.

Before the land is allowed to lie fallow, farmers practice a crop rotation system where the succession of crops is based on the perceived nutrient requirements of each crop or crop association and the nutrient extraction of the previous crop(s). Tables 4.9 and 4.10 depict the fallow rotation systems adopted in Malende and Koudandeng.

Table 4.9 Fallow Rotation Systems in Koudandeng

Order	*Fallow Rotation System*			*% House-holds*
	1st crop/crop association	*2nd crop/crop association or field use*	*3rd Crop/crop asso-ciation or field use*	
1	Plantain/banana based fields	Groundnut/cassava-based fields	Fallow	10.8
	Plantain/banana based fields	Fallow		10.8
2	Yam based fields	Groundnut/cassava-based fields	Fallow	45.9
3	Beans based fields	Groundnut/cassava-based fields	Fallow	2.7
4	Maize based fields	Groundnut/cassava-based fields	Fallow	73.0
5	Cocoyam based fields	Groundnut/cassava-based fields	Fallow	5.4
	Cocoyam based fields	Fallow		5.4
6	Sweet potato based fields	Groundnut/cassava-based fields	Fallow	81.1
7	Onion fields	Groundnut/cassava-based fields	Fallow	10.8
8	Egusi based fields	Groundnut/cassava-based fields	Fallow	16.2
9	Groundnut/cassava-based fields	Fallow		94.6
	Groundnut/cassava-based fields	Maize or Sweet potato based fields	Fallow	5.4
10	Cassava-based fields	Fallow		16.2
11	Okra fields	Groundnut/cassava-based fields	Fallow	16.2

Source: Household survey and freelisting follow-up interviews.

Table 4.10 Fallow Rotation Systems in Malende

Order	*Fallow Rotation System*				*% house-holds*
	1st Crop/crop association	*2nd crop/crop association or field type*	*3rd crop/ crop association or field type*	*4th crop/crop association or field type*	
1	Calaba yam based fields	Cassava/maize/groundnut-based fields	Fallow		5.5
	Calaba yam based fields	Cassava/egusi-based fields	Fallow		5.5
2	Cassava-based fields	Maize based	Fallow		
	Cassava/cocoa fields	Fallow			3.6
	Cassava-based fields	Sweet potato/cocoyam-based fields	Fallow		3.6
	Cassava-based fields	Fallow	Cassava-based fields	Fallow	69.1
	Cassava-based fields	Cocoa/fruit trees/plantain-based fields	Perennial Fields		9.1
3	Cocoyam or colocasia based fields	Cocoyam or colocasia-based	Fallow		25.4
4	Egusi based fields	Fallow			9.1
	Egusi based fields	Plantain or egusi-based fields	Fallow		5.4
5	Green leafy vegetable fields	Green leafy vegetable fields	Fallow		7.3
6	Groundnut/cassava/maize based fields	Fallow			5.4
	Groundnut/cassava/maize based fields	Groundnut/cassava/maize or cassava-based fields	Fallow		5.4
7	Maize based fields	Maize or cassava/maize-based fields	Fallow		14.5
8	Pineapple fields	Cassava	Cocoa	Fallow	7.3
9	Plantain based fields	Fallow			16.4
	Plantain/egusi based fields	Fallow			7.3
	Plantain/oil palm	Fallow			7.3
	Plantain/cassava	Sweet potato	Fallow		3.6
10	Sweet potato or sweet yam based fields	Fallow			3.6
11	Tomato fields	Fallow			3.6
12	Water yam based fields	Water yam or cassava/maize fields	Fallow		7.3
13	Yam based fields	Maize or yam-based fields	Fallow		7.3

Source: Household survey and freelisting follow-up interviews.

In Koudandeng, groundnut-cassava-based cropping systems come last in a crop rotation before the field is allowed to lie fallow. According to farmers, cassava has the ability to extract nutrients from low nutrient soils (commonly called 'old' soils), while groundnut improves the fertility of such soils and thus facilitates the growth and establishment of other companion crops. Gertrude explained:

> Crops such as plantain, banana, cocoyam, maize, and egusi are high nutrient demanding and their fields are most often established by clearing forest vegetation. After harvest, the fields are planted as groundnut fields. When groundnuts and other associated crops are harvested, cassava is left in the fields and harvested as needed. After cassava is harvested, the soil must be left for a few years to build up its nutrients. Cocoyam and plantain are semi-perennial crops and can last in the field for about five years, and so their fields are often converted into groundnut fields when the harvest is not complete and some staggered crops are left standing. The soil is just like a human body that needs to eat and grow.

In this farmer's opinion, cassava regenerates the soil for the succession crop through its stems, which are returned to the soil as residues.

Numbem (1998) stated that Southern Cameroonian farmers associate specific types of crops with fallow fields of specific ages to suite the biophysical and phenological needs of these crops. These farmers grow semi-annual crops such as plantain and cocoyam in forest fields, whereas annual crops are grown in short (2-6 year) fallow fields. Egusi, which is an annual and shade tolerant crop, is often planted in established forest fields. A farmer begins by establishing forest fields called *esep* which are allowed to go into an intermediate fallow of a few years (two to three years) called *ekwapk*, after which annual crop fields, such as groundnut-cassava-based and sweet potato based polycultures, are established. These are termed *ekwapk* fields. Guyer (1977), in her study of women's farming systems in the Lekie Division of Cameroon, found that *esep* fields are established during the dry season on land cleared from virgin forests or long duration fallows.

Traditionally, cassava-based polyculture fields come last in a crop rotation system. This is not done in Malende, where farmers depend on both rented and own land. However, Table 4.10 highlights the fact that most cassava-based polyculture fields are left fallow after the last crop, usually cassava, is harvested. Some farmers who grew perennial crops such as cocoa, oil palm, or fruit trees in succession to a cassava-based polyculture field reported that cassava improves the fertility of the soil through its residues and makes the soil fit for growing perennial crops with root zones that are more expansive compared to the root zones of annual crops.

In cassava-based polyculture fields, fallowing of land after the cassava crop is harvested is used to improve soil fertility. Table 4.11 highlights the fact that fallow lengths in the study area are varied, ranging between two to six years in Koudandeng and six months to two years in Malende. Previous research in Malende (Nchang Ntumngia, 1997: 60) showed that fallow lengths ranged from two to three years. Ngobo (2002) indicated that the average fallow length in the Yaounde block (to which Koudandeng belongs) is 3.9 years. A discussion with some elderly women farmers (40 years to 75 years) in Koudandeng indicated that, compared to their youths, fallow lengths reduced from over 10 years to less than six years. Two elderly (about 60 year-old) women natives in Malende reported that fallows have reduced from 10 years to less than two years as a result of increased commercialisation of domestic food crops. According to them, farmers now are more interested in rapid sales turnover, as well as reducing the cost of labour entailed in managing long duration fallow vegetation.Table 4.11 shows that there is a tendency toward an increase in the length of fallows for both villages between 2003 and 2007, which is contrary to the assumption that fallow lengths in Africa are decreasing. It can thus be reasonably concluded that, if fallows periods have decreased in the relatively distant past, they now appear to be increasing.

Table 4.11 Fallow Lengths After the Harvest of Companion Crops in Cassava-based Polyculture Fields, 2003 and 2007

Average fallow lengths	*% Farmers Keeping Fallows of a Specific Duration*			
	Koudandeng		*Malende*	
	2003 (n = 114)	*2007 (n = 21)*	*2003 (n = 92)*	*2007 (n = 46)*
3 months	0.0	0.0	30.4	2.2
6 months	0.9	0.0	6.5	54.3
9 months	-	-	11.9	-
1 year	4.4	0.0	10.9	19.6
2 years	38.6	19.0	28.3	21.7
3 years	31.6	52.4	6.5	0.0
4 years	14.0	47.6	2.2	0.0
5 years	7.0	52.4	3.3	2.2
6 years	0.9	14.3	0.0	0.0
7 years	1.7	0.0	0.0	0.0
8 years	0.0	0.0	0.0	0.0
9 years	0.0	0.0	0.0	0.0
10 years	0.9	0.0	0.0	0.0

Source: Household survey and freelisting follow-up interviews.

Farmers in more subsistence-oriented Koudandeng maintain longer fallows relative to farmers in more commercially oriented Malende. Apart from the need to earn cash (explained above), farmers' local evaluation of the fertility of their soils partly accounts for the variation in fallow lengths between the two villages. In Koundandeng, which has longer fallows, the common response to the question posed about why they maintain fallows of specific lengths was, "the soil is like a human body that needs food in order to grow or stay alive.

Overworked soils need to be allowed some time to regain their fertility." In contrast, Malende farmers explained that their soils are fertile and do not require long fallows because they are composed of volcanic deposits and plant debris from runoff water and river sediments.

The variation in fallow lengths depends on a number of factors, such as farmers' production orientation (subsistence versus commercial), socioeconomic attributes, and agroecological practices and characteristics. The results of a regression analysis of fallow lengths on these factors are presented in Table 4.12.

Table 4.12 Factors Determining Fallow Lengths in Malende and Koudandeng

Determinants	*Koudandeng*			*Malende*		
	B	*SE B*	*β*	*B*	*SE B*	*β*
Constant	5.795	0.968		3.377	0.569	
Sex	0.000	0.000		0.000	0.000	
Age	-0.030	0.009	.319*	0.000	0.000	
Household headship	0.000	0.000		0.000	0.000	
Level of education	0.150	0.046	.335*	-0.109	0.028	-.468**
Household HIV/AIDS status	0.000	0.000		0.000	0.000	
Family size (dependents)	0.000	0.000		0.000	0.000	
Field location	0.561	0.227	.238*	-0.745	0.284	-.316*
Fertiliser use or non use	1.471	0.229	.482**	0.000	0.000	
Land tenure				0.000	0.000	

Note: Koudandeng: $R^2 = .696$; adjusted $R^2 = 0.662$. (*p < .05; ** p <.001)
Malende: R^2)= 0.315; adjusted $R^2 = 0.286$ (*p < .05; ** p<.001)

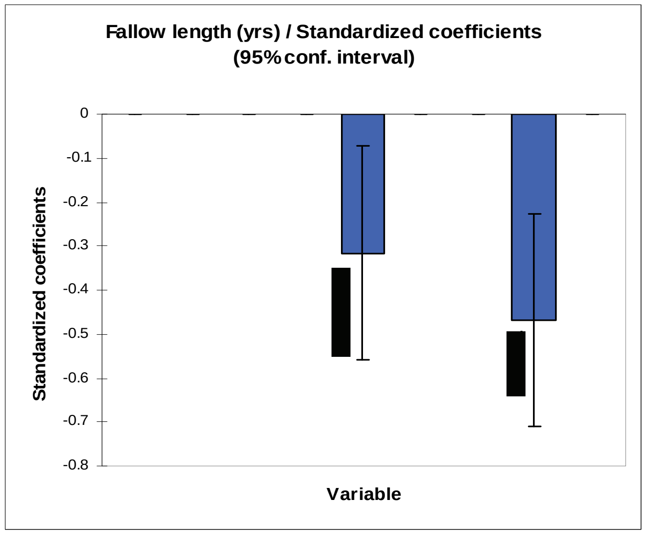
To further understand which pressures determine the length of fallows in the two villages, a regression of fallow length on farmers' socioeconomic attributes and agroecological practices and characteristics was performed (Table 4.12 and Figure 4.3), which shows that farmer's age, level of education, field location, and fertiliser use are significant determinants of the variation in fallow lengths among Koudandeng farmers, where some 69.6% of the variation is explained by these factors. Farmer's age is inversely correlated with length of fallows, implying that older farmers keep shorter fallows relative to younger ones. More distant fields are kept longer under fallow compared to nearby fields. This may be due to the fact that the local transport system in Koudandeng is poorer, farmers travel more often to their fields, and it takes between two and three hours to reach distant fields (see Chapter 2). Some female farmers indicated that, if they had the choice, they would prefer to manage fields that are closer to home save time walking to their fields and to facilitate food procurement for families and guests when faced with time constraints.

Table 4.12 and Figure 4.3 also show that higher education is positively correlated with the length of fallow, implying that Koudandeng farmers with a higher level of education tend to keep longer fallows relative to the less educated. As discussed earlier, Koudandeng soils are only moderately fertile, so continuous cultivation without fallowing reduces fertility faster, which may eventually lead to a need for fertilisers. A cross tabulation of fertiliser use by fallow length showed an X^2 significance at the .05 level. Some 15% of Koudandeng farmers use some amount of fertiliser in polyculture fields. A closer examination of the data showed that all of the farmers that indicated that they use fertilisers keep shortened fallows compared to those who do not use fertilisers. Some of the farmers who use fertilisers reported that they confront problems of land scarcity and thus fallows are reduced to one year.

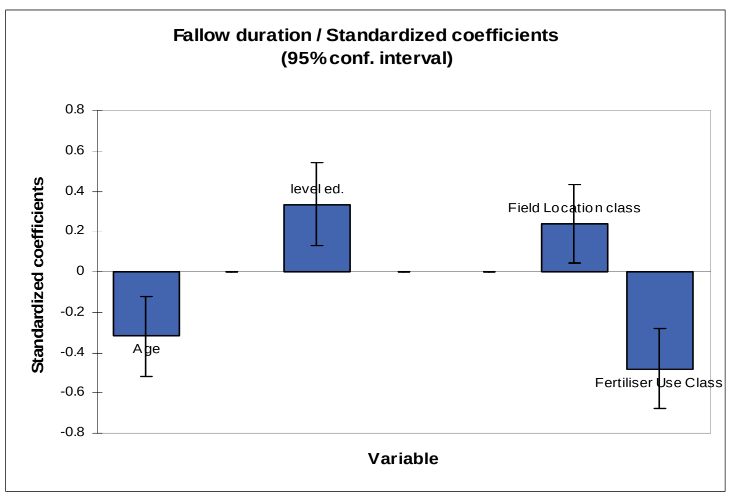
In Malende, the level of education and field location explain 31.5% of the variation in fallow lengths, but are inversely related to fallow length. What this means is that, as farmers' level of education increases, fallow length decreases and, the more distant the field, the shorter the fallow. More educated farmers engage in farming as a secondary livelihood activity (main activities are teaching and other white collar jobs). Some of them said that their farming activities are only performed only on weekends (mainly on Saturdays, since Sundays are reserved for religious ceremonies and social activities). Due to such time constraints, they prefer to manage fields that have been left to fallow for only short periods since these present less thick vegetation to clear or weed.

Figure 4.3 Standardised Coefficients of Fallow Lengths

a) Malende



b) Koudandeng



Most of Malende's fields are located at distant sites in the secondary or primary forests of Mile 40 and along the Moungo River (see Chapter 2). Farmers estimate that their soils are fertile and thus short fallow lengths are sufficient to regenerate fertility. Shortened fallow lengths that result from the distance of fields and farmer's age are indicators of labour constraints. Most Koudandeng women indicated that groundnut/cassava-based polyculture fields are often established last in a crop rotation after other food crop fields because this reduces the amount of labour involved in land preparation. For example, groundnut/cassava and other companion crops are planted immediately after sweet potato or maize fields are harvested. Numbem (1998) reported that, given the pressure on land for food production and the high labour demands for land clearing that Southern Cameroonian households confront, farmers prefer to keep short fallows (2-6 years). Eastern Cameroonian farmers also keep short fallow lengths to reduce the amount of labour involved in clearing and felling trees in fallow vegetation fields that is implied by fallows of seven to 10 years (Ickowitz, 2004).

It can be said that farmers' labour constraints are better explanations for the lengths of fallow compared to low yields as the Government of Cameroon, AGRA, and researchers purport. Also, promoting the use of fertilisers encourages farmers to reduce fallow lengths, which has implications for soil fertility and therefore yields.

Chromolaena odorata, an exotic weed introduced from tropical America, is an important invasive weed in these fallow fields (Roder et al., 1995; Weise, 1995; Numbem, 1998; Weise and Tchamou, 1999; Gillison, 2000; Ngobo, 2002; Ngobo et al., 2004; Ickowitz, 2004; Nolte et al., 2007). These researchers report that it makes significant contributions to soil fertility through high litter production and rapid soil coverage (reduced soil exposure). Its ability to enhance soil nutrient availability increases plant diversity in short fallows, which in turn increases the amount of litter and biomass that is returned to the soil when these are cleared and burned. Slaats et al. (1996) and Ickowitz (2004) indicated that studies in the southwest of Côte d'Ivoire found that *Chromolaena odorata* rapidly establishes soil cover, suppresses herbaceous species, and accumulates significant amounts of nutrients and carbon during the initial fallow period.

A similar study by Ngobo (2002) in Southern Cameroon showed that cassava/maize/ groundnut polyculture fields that were established on fallows previously dominated by *Chromolaena odorata* had fewer weed species (93) relative to those that were established on previous forest vegetation plots (103). The weed flora composition (density, frequency, and ground cover) of fields that are associated with *Chromolaena odorata* consists of*: Sida rhombifolia* L, *Stachytarhpeta cayennensis* (Rich) J. Vahl, *Triumfetta cordifolia* A. Rich, *Ageratum cenzoides* L., *Trema orientalis* L. Blume, *Cogniauxia podolaena* Baill, and *Mikania cordorata* B.L. Rob.

Ickowitz (2004) noted that farmers shorten fallows in fields that have been invaded by *Chromolaena odorata* because a shorter fallow is sufficient to regenerate soils. Ngobo (Ibid.) found in her analysis of the soil composition of cassava/maize/groundnut polyculture fields that were established on previously *Chromolaena odorata* dominated fallows in Southern Cameroon had low clay and silt content, low bulk density, and low acidity. Table 4.13 presents the structural vegetation data for a *Chromolaena odorata* fallow and newly established cassava/groundnut polyculture field in Mbalmayo, Cameroon (Gillison, 2000).

In conclusion, contrary to the assumption that fallow lengths in Africa are decreasing, the findings of this study show that, if fallow periods have decreased in the relatively distant past, they now appear to be increasing. Fallow lengths are varied and depend on farmers' production orientation (subsistence versus commercial), socioeconomic attributes (age, level of education), agroecological practices (fertiliser use or non use) and characteristics (field location) and farmers' perceptions (farmers' local evaluation of soil fertility). Age, field location and, to some extent, education (farming as a secondary activity for more educated farmers) are indicators of labour availability, which points to the fact that farmers' labour constraints are better explanations for the lengths of fallow compared to low yields as is purported. The fact that shortened fallows (1-2 year) lead some Koudandeng farmers to use fertilisers to increase production implies that promoting the use of fertilisers will encourage farmers to reduce fallow lengths, which has implications for soil fertility and therefore yields.

Table 4.13 Structural Vegetation Data of *Chromolaena odorata* and Polyculture Fields in Mbalamayo, Cameroon

Field Type	*Mean Canopy Height*	*% Crown Cover*	*Woody plants (< 1.5m tall)*	*Bryophyte cover abundance*	*Litter*	*Mean Basal Area (m^2 ha^{-1})*
Chromolaena fallow	20	95	2	2	8	2
Newly established groundnut/cassava fields	0.40	5	2	1	0	0.50
8–10 year Chromolaena Fallow	3.5	95	8	3	2	7.33

Source: Adapted from Gillison, 2000.

Conventional wisdom, which poses that shortened fallow periods are a main cause of soil infertility and declining crop yields, is contested by the findings in this study because reduced fallow length does not necessarily imply a "breakdown" in soil fertility. The type and diversity of fallow vegetation cover modifies soil characteristics and maintains or improves soil fertility. For example, *Chromolaena odorata*, which is an important invasive weed in fallow fields in Malende and Koudandeng, enhances soil nutrient availability through rapid soil coverage (reduced soil exposure) and high litter and biomass production that is returned to the soil when cleared and burned. Furthermore, farmers adopt a series of strategies to improve the fertility of their soils, including:

i. The management of vegetation cover through slash and burn where the burnt biomass and litter releases a stock of nutrients (cations: Ca, Mg, K, and Na, as well as P) in ash which increases the soil pH, the amount of basic cations and the level of cation exchange capacity (CEC) of the soil;
ii. Preferential placement of crops in microsites according to their specific nutrient requirements;
iii. Employment of the principle of the fertility economy of trees through their agroforestry practices that preserve meaningful herbaceous plants, shrubs, medicinal, and fruit trees and spices during land clearing, burning, and weeding. These appropriate and accumulate soil basic cations (Ca, Mg, K, and Na) and phosphorus (P) from soil depths into vegetal biomass that are released through burning and slow decay when trees are cut and burnt for crop cultivation;
iv. Planting cover crops and legume trees;
v. Practicing crop rotation systems where crop successions are based on the perceived nutrient requirements of each crop or crop association and the nutrient extraction of the previous crop(s). In such systems, cassava-based associations come last in a crop rotation before a field is left to fallow. Cassava regenerates the soil for the succession crop through its stems, which are returned to the soil as residues;

vi. Associating specific types of crops with fallow fields of specific ages to suit the biophysical and phenological needs of these crops. For example, farmers grow semi-annual crops such as plantain and cocoyam in forest fields, whereas annual crops are grown in short (2-6 year) fallow fields.

4.7.3 Evaluation of Soil Fertility through Vegetation Cover

Farmers in both villages determine the fertility of their soils for agriculture based on their perceived evaluation of field vegetation type. Malende farmers describe the areas that are fit for establishing cassava-based polyculture fields as those that contain fallow vegetation that has shrubby trees with thick understory grass, thick bush with tall, difficult to clear grass, and where a particular cover locally called '*acha casara*' (*Chromolaena odorata*), as well as elephant stalk (ekeki - *Pennisetum purpureus*) are present. Koudandeng farmers describe the fertility of their soils in terms of the presence of specific vegetation such as *apara ekoro*, *zizim*, *ekeki*, and *doedzome*. They stated that the size and height of these different weedy species indicate the length of time that the land has been in fallow and therefore the fertility of the land in question. It is believed that *apara ekoro* grass in particular increases cassava yields, or 'brings' cassava. Two prominent and highly respected female farmers (Gertrude and Régine) and another farmer, Albertine, also reported that long duration fallows (> five years) usually exhibit small mounds of soil as a result of the action of earthworms. It can be concluded that farmers' perceptions (local evaluations) of the vegetation cover is an important factor in soil fertility management and maintenance.

4.7.4 Crop Residue Management

The assumption that African farmers mine their soils, which make traditional African farming systems unsustainable, is contested in that the incorporation of crop residues into the soil is a viable and pervasive soil fertility improvement strategy. This assumption implies that soil nutrients are extracted through harvest with no returns to the soil. It is argued that not all of the plant parts (above ground and below ground) are removed from farmers' fields and a reasonable amount of nutrients are returned to the soil in the form of crop residues (biomass), an aspect that is neglected in policies and interventions that promote fertiliser use.

Studies show that crop nutrient requirements, or the amount of nutrients extracted in crop root and foliar harvest, is highly dependent on growth rate and yield, which in turn depend on climate, soil fertility conditions (texture, moisture content, temperature, available cations, CEC rate, phosphorus, potassium and nitrogen availability, types of previous vegetation etc), cropping intensity, and crop variety (Leihner, 1983; Sanyal and De Datta, 1991; Olasantan et al., 1996; TSBF-CIAT, 2009). The climate and soil fertility conditions in Koudandeng and Malende discussed above are favourable for crop production, especially of the different crop components in the polyculture cassava fields. This implies that the growth rate and yields of these component crops are not necessarily low, even though they may be lower relative to that of individual crops planted in monoculture.

Table 4.14 depicts the amount of nutrients that are extracted by some crop parts, which can be used as an indication of the amount of nutrients that are recycled in cassava polyculture fields. This table highlights the fact that, the greater the diversity of crops in a field, the higher the amount of residues that are returned to the soil and therefore the higher the amount of nutrients that are recycled. Therefore, a greater amount of nutrients are recycled in cassava-based polyculture fields relative to monoculture fields.

Table 4.14 Nutrient Concentration (Amount Extracted) of Some Crop Residues and Weeds

Crop and Part of Crop	*Value of mineral nutrients in kg ton^{1} of crop residue*						
	N	*P*	*K*	*Ca*	*Mg*	*Lignin*	*Total Soluble PP*
Groundnut leaf	32.5	1.8	24.1	13.4	4.0	50.8	28.7
Cassava leafy litter	29.8	1.9	7.3	10.9	5.6	375.2	
Banana/plantain leaf	19.0	1.2	21.9	11.6	3.2	107.5	11.4
Banana/plantain stem	6.0	1.2	39.7	3.9	3.0	54.9	0.1
Maize leaf	13.8	1.3	11.5	2.2	1.9	129.0	7.7
Maize Stover	8.3	0.8	12.5	3.4	1.9	88.2	7.4
Pennisetum purpureus leaf *	22.5	1.3	21.0	12.6	1.4	47.1	1.8

*Grassy weed referred to as sisongo, Source: Adapted from TSBF-CIAT (2009).

It would seem that the aggregate level of nutrient extraction from the soil by all of the crop components taken together per unit area may be higher relative to the amount of nutrient extracted from the same unit area of land that is planted to a single crop. Leihner (1983) argues that crop associations represent an intensification of nutrient demands so that, under intensive management, the rate of nutrient extraction and removal is greater in a polyculture system than in monoculture, especially when the above ground parts of the plants are not re-incorporated into the soil as residues.

It is argued here that the level of nutrient extraction of each crop component in a polyculture system is lower than if it were grown in monoculture because the cropping density of each component crop in polyculture systems is reduced, which in turn leads to lower individual crop yields on a per land unit basis. Low individual crop yields imply low individual crop nutrient extraction from the soil and therefore the aggregate nutrient extraction in polyculture fields is lower and varied relative to the nutrient extraction of individual crops in monoculture. Relatively lower individual crop yields do not imply lower aggregate crop residues and biomass that are returned to the soil.

The relationship between high crop yield and high levels of soil nutrient extraction has been emphasised in the literature. For example, Fermont et al. (2007) reported that cassava HYVs increase the risk of soil nutrient mining because their high yields put more pressure on soil nutrient stocks. Using the example of a comparative study carried out in Kenya and Uganda, these authors found that a local cassava variety that yields about 10t ha^{1} extracts 26 kg N, 3 kg P, and 19 kg K per ha, whereas an improved CMD resistant variety yields about 30t ha^{1} and extracts 83 kg N, 10 kg P, and 47 kg K per ha. The fact that cassava HYVs are virtually not grown in Koudandeng (less than two percent of all farmers grew them in 2007, see Chapter 5) means that fewer nutrients are extracted by the local varieties that are grown, and thus soils are not being mined, at least to the extent that they would be mined if HYVs predominated. Based on this reasoning, while individual crop yields are lower in polyculture systems compared to monoculture systems, the soils in polyculture systems in Koudandeng will be less degraded.

Fermont et al.’s (2007) argument that, without fertiliser application, soil nutrient stocks are rapidly depleted when cassava HYVs are grown, is here partially disputed because HYVs also have high concentrations of nutrients such as phosphorus, nitrogen, and potassium that are returned to the soil and recycled through biomass and litter. Moreover, farmers reported that some local varieties are higher yielding than the HYVs in Malende and Koudandeng. The main issue here should be that continuous cropping without nutrient recycling will lead to rapid depletion of soil nutrient stocks no matter which varieties are grown.

Furthermore, the successional aspect of crops in farmers' polyculture fields ensures the continuous re-incorporation of nutrients into the soil throughout the production cycles of all companion crops. For example, farmers' crop combinations are such that the timing of crop harvest facilitates nutrient recycling. The above ground residues of short growth cycle crops such as egusi, groundnut, and maize are returned to the soil during harvest which, with decomposition, increases the availability of nutrients for long cycle crops such as cassava, yam, plantain, cocoyam, and taro. Also, the stumps of harvested green leafy vegetables are returned to the soil as are the residues of long growth cycle crops, which are returned as biomass and litter after harvest. Apart from the fact that harvested cassava roots are sometimes removed from the fields and thus this biomass is not returned to the same fields in which the crop was grown (although peels are recycled in other places, such as homegardens), all of the above ground plant parts are returned to the soil. Even when the cuttings are transported to other fields, these are returned to the soil through planting. In Koudandeng, where cassava leaves are eaten, nutrients that are exported in the leaves are partially returned to the soil since not all of the leaves are harvested. Thus, even though the aggregate rate of nutrient extraction by component crops in polyculture systems is high, the rate of nutrient recycling is faster and continuous, and the amount of nutrients that are recycled is greater compared to that in monoculture fields.

Farmers practice selective weeding by cutting back, but not uprooting, herbaceous plants and shrubs and, once crops are harvested, these become part of the succession. During weeding and harvesting of short growth cycle crops, the residues and weeds are used as mulch, which is spread around cassava and other long-growth cycled companion crops. This modifies the microclimate around these crops and provides sufficient biomass that decomposes quickly enough to improve the soil nutrient balance.

The combination of crops that facilitate rather than compete for nutrients, e.g. legumes/root and tuber crops in cassava-based polyculture fields (see above) reduces the amount of each nutrient that is extracted compared to the amount that is extracted by individual crops in monoculture. This permits crops that can tolerate certain levels of nutrient deficiency (such as cassava) to perform well.

In conclusion, the hypothesis that African soils are virtually mined without replenishment is rejected. Policies and interventions that promote fertiliser use neglect the residue management that constitutes a major component of traditional African farming systems. While crop growth rates and yield determine the amount of nutrients extracted in crop root and foliar harvest, crop diversity and succession in polyculture fields influence the amount of residues that are returned into the soil and therefore the amount of nutrients that are recycled. While the aggregate level of nutrient extraction in a polyculture field may be high, the low individual crop density (crop population) reduces the amount of nutrients that are extracted by individual crops. Thus, the level of nutrient extraction of each crop component in a polyculture system is lower than if the same crop were grown in monoculture, which makes the soils in polyculture fields less degraded than those in monoculture fields.

The diversity of crops in a polyculture field also diversifies the types of nutrients extracted as well as reducing the amount of specific nutrients that are extracted, and thus nutrient deficiencies would be unlikely to exceed the thresholds that are required for crop growth.

Farmers' temporal crop combination strategies facilitate continuous, high, and fast rate of nutrient recycling as compared to monoculture fields. Other strategies to ensure nutrient recycling in polyculture fields include: selective weeding where herbaceous plants and shrubs are pruned, mulching using weeds and crop residues, and combining crops that facilitate rather than compete for nutrients, which reduces the amount of specific nutrients that are extracted. It is argued that continuous cropping without nutrient recycling will lead to rapid depletion of soil nutrient stocks.

4.7.5 Constraints on Fertiliser Use

Here it is argued that policies and interventions that promote the use of fertiliser may undermine traditional agroecological systems without providing compensating benefits over time. There are technical and practical limitations to the efficient and effective use of fertilisers in traditional cassava-based polyculture systems. The difficulties entailed in estimating the correct soil nutrient balance and in recommending crop nutrient requirements constitute the technical constraints. The practical limitations include: the difficulties entailed in manufacturing fertiliser mixes for broad based applicability, the inappropriateness of recommended soil experiment and testing approaches for farmers, the implications for the sustainability of traditional polyculture systems due to the tendency toward reduced fallow lengths when fertilisers are used, the high prices of and access to agrochemicals, as well as risks to health hazards from high concentration of chemicals in crops.

4.7.5.1 Problems with nutrient calculations

TSBF-CIAT (and, by association, AGRA) acknowledges the difficulty involved in combining external inputs and traditional soil fertility improvement techniques to improve the productivity of cassava in polyculture systems. The nutrient requirements (soil nutrient balance) of a crop have always been calculated based on its level of nutrient uptake and the amount of nutrient inputs into the soil on which the crop is grown corrected with the nutrient reserve stored in the root layer. The problems related with this calculation are twofold: the use of average values of nutrient uptake and the difficulties entailed in estimating the uptake efficiency of the crops and the amount of soil nutrient inputs.

The amount of nutrient uptake or removal by a crop depends on climatic conditions and the nutrient status of the soil, the variety used, yield levels obtained, and the plant parts that are either removed for use or returned to the soil as residue. Howeler (2001), critiquing other scholars (Howeler, 1981, 1991; Putthachcroen et al., 1998), emphasises the fact that basing nutrient removal calculations for a particular crop on average removal data either leads to an under- or over-estimation of nutrient removal (uptake) values. Nutrient removal values are under-estimated in the case of high yields, whereas low yields lead to over-estimated values. Using averages as the measure of nutrient removal also obviates the fact that the nutrients removed by crop residues are returned to the soil through nutrient recycling. Table 4.15 presents some data on the nutrient uptake and requirements of some companion crops in a cassava polyculture system.

Table 4.15 Nutrient Uptake and Requirements of some Companion Crops in a Cassava-based Polyculture System

Crop	*Yield (t/ha)*	*Nutrient Uptake (kg ha⁻¹)*										
		N	*P*	*K*	*Ca*	*Mg*	*Na*	*B*	*Zn*	*Mn*	*S*	*Fe*
Cassava roots	29	67	88	11	14	7.9		0.19			14	
Groundnut	3000	192	48	80								
Egusi melon	30	78	9	73								
Maize	9.5	129	40	29	2	18		0.005	0.023	0.004	12	0.03
Plantain	30	250	46	702	252	100					24	
Okra	20	79	32	89	38	15						
Huckleberry												
Cocoyam	20	640	840	420	212							
	Optimum Nutrient Requirements (exchangeable or available cations)											
	Exchangeable cations (mg 100g⁻¹ soil)							*Available micronutrients (ppm)*				
Crop	*pH level*	*Exchange-able Al.*	*N (ppm)*	*K*	*Ca*	*Mg*	*Na saturation*	*B*	*Zn*	*Mn*	*S*	*P*
Cassava roots	4.5 - 7.5	< 80%		0.17	0.2		< 2.5%		> 1	> 5	> 8	> 5
Groundnut			50	0.5	0.5			0.1			20	20
Egusi melon												
Maize			5.3	4.42								2.06
Plantain												
Okra												
Huckleberry												
Cocoyam	5.8		8	5								

Note: This data, which is based on studies carried out by other scholars, were calculated using averages.

Source: Fox, 1989; Howeler, 2001; Hillocks et al., 2002; Ghosch, 2003; Heckman et al., 2003; Saïdou, 2006; Singh et al., 2007; Grubben and Kerns, 2004; LINK, 2008.

In most cases, soil nutrient balance values are calculated using data from experiments that have been done on station (researchers' milieu) where yields are much higher than those obtained by farmers (Howeler, 2001). Consequently, the data reflects higher amounts of nutrient uptake or removal than are actually encountered in farmers' fields. When such data are used to calculate nutrient requirements for specific crops, faulty recommendations are made that have implications for nutrient balances in the soils of farmers' fields, if these are applied.

Also, nutrient uptake and optimum requirements for specific crops are presented in relation to monoculture fields that are not applicable to farmers' polyculture fields. A few attempts to calculate nutrient uptake and requirements have been made for an association of two or three crops in a field, such as for a maize-cassava association (Olasantan et al., 1996, Saïdou, 2006), a cassava-mungbean association (Leihner, 1983), or a cassava-cowpea association (CIAT, 1980), and for cassava-egusi-melon and maize/cotton associations (Saïdou, 2006). Analysis of the different combinations of cassava-based polyculture systems in Malende and Koudandeng, presented in tables 4.3 and 4.4, respectively, highlight the fact that at least six to seven companion crops are planted at the same time in a field.

Estimating nutrient removal and optimum requirements for such crop combinations can be painstaking and costly. The common practice of using a reference crop or the most

economically important crops limits researchers' analyses and thus they may not be able or willing to undertake a full analysis. In this, any recommendations made in relation to fertiliser application will have implications for the soil nutrient balance in farmers' fields. The consequences may be decreased yields and soil mineral/nutrient saturation.

Apart from nutrient uptake by plants, available soil nutrients are also lost by erosion through percolation and runoff water. Howeler (2001) highlights the difficulties entailed in estimating the amount of nutrients lost through erosion. Measurements in one part of a field containing a slope may be incorrect, since some soluble nutrients that are carried away in runoff water infiltrate and are absorbed by plants in other parts of the field. Nutrient erosion also depends on the intensity and frequency of rainfall, which varies over time and in space. Howeler (2001) states that, most often, data on eroded soil deposits and atmospheric deposits are not readily available, which leads to the calculation of nutrient balance for each crop and soil on the basis of nutrient inputs and nutrient outflow (crop removal), which are more easily calculated. As measures of the level of accumulation or depletion of a particular nutrient, nutrient balances are therefore partial, since other sources of nutrient input or outflow are either considered to be of less importance or are difficult to estimate. Different companion crops in a cassava polyculture system have different patterns of response to various nutrients that are difficult to determine, so estimating nutrient requirements is difficult. Leihner (1983) argued that no conclusions about fertiliser requirements for an intercropping system can be derived solely on the basis of nutrient data for monoculture crops. In order to ensure an adequate and economic supply of nutrients in a cassava polyculture system, one has to study the response to each nutrient of all the companion crops when grown in association under different soil conditions. This is certainly difficult to achieve in dealing with complex polyculture systems such as those of Koudandeng and Malende.

Obtaining nutrient balances and requirements also requires an analysis of soil composition. Apart from residue nutrient recycling, soil fertility also depends on the vegetation that existed before crops were grown, fluvial and runoff water debris (in the case of fluvisols and alluvisols), and the mineral composition of the parent rock and the soils before cultivation. These aspects have been neglected in the literature that deals with the estimation of nutrient balance and recommendations about the nutrient requirements of each crop. Neglecting these aspects may either lead to over-estimated or under-estimated recommendations, which may upset the nutrient balance of cassava polyculture fields.

In conclusion, it can be said that making correct recommendations for fertiliser use requires a more holistic approach to the calculations for individual farmers' fields' soil nutrient balance. Soil nutrient balance in a cassava-based polyculture field not only depends on partial amounts of nutrient outflow and inflow, but also on other factors such as:

i. Differential patterns of response to various nutrients by companion crops;
ii. The amount of nutrient loss through erosion, which depends on the variation in the intensity and frequency of rainfall;
iii. The amount of eroded soil and atmospheric deposits;
iv. The continuous deposits of fluvial and runoff water debris;
v. Recycling of nutrients through crop residues.

The difficulties entailed in estimating values related to most of these factors have often limited the calculations for soil nutrient balance and crop nutrient requirements to the amount of nutrient outflow through crop removal and inflow from manure and fertiliser, which are easily estimated. As such, the values obtained are only partial since the sources that are either of minor importance or difficult to quantify are neglected. Actual crop uptake efficiency and the amount of soil nutrient input are therefore not obtained.

Using average values rather than site- and time-specific data in calculating soil nutrient balance is a major limitation of this approach, which leads to either an underestimation or overestimation of nutrient uptake values. Also, using optimal values of crop yields based on reference crops that are grown in monoculture and under researchers' conditions to make leads to underestimation or estimation of soil nutrient balance.

Incorrect estimation of soil nutrient balances will lead to incorrect technical recommendations. The consequences of incorrect recommendations are varied, ranging from low crop yields in the case of excess nitrogen application (Kasele, 1980; TSBF-CIAT, 2009) and increased depletion of some nutrients, to increased costs due to wasted fertilisers.

4.7.5.2 Lack of appropriate fertiliser mixes

The possibilities to increase cassava yields by using agrochemicals in intercropped polyculture systems are limited and problematic because the nutrient requirements of intercropped systems are unknown, and there are no broad based fertilisers and herbicides that have been developed for application in such fields. Different crops have different nutrient requirements and, in association, their nutrient requirements can also be expected to change. Also, farmers manage many food crop fields with varied soil composition; the soil composition of a farmer's field varies from one end of the field to the other, which would require different types and dosages of chemical fertilisers. Manufacturing fertiliser to respond to farmers' diverse ecological niches for broad base application may prove to be difficult since fertiliser firms are unlikely to find such custom-made fertiliser blends to be profitable.

4.7.5.3 Inappropriateness of recommended experiments and tests

TSBF-CIAT (2009: 122-31) and, therefore, AGRA, propose that farmers and extensionists should experiment with and apply knowledge-intensive Integrated Soil Fertility Management methods. These include: soil fertility diagnosis through the nutrient deficiency symptoms expressed by plants (tip burns and leaf colour-chlorosis and necrosis), soil sampling analysis using soil test kits or laboratory analysis, field testing of the most limiting nutrient, and reliance upon remote sensing, expert systems, and crop simulation models. The procedure prescribed by CIAT indicates that the interpretation of the results of soil analysis using these methods should be based on the identification and hierarchisation (prioritisation) of limiting nutrients, the expected crop response to applying limiting nutrients, and the costs and expected economic returns entailed. Profitable results would be approved, validated, and fine-tuned to suit different levels of production and distributed to farmer associations through extension bulletins.

These methods, however scientifically sound, are not likely to be adapted to most farmers' or extensionists conditions: they are either time consuming, expensive, not very appropriate, involve a lot of waste (expired reagents when test kits are used), are based on the interpretative diagnostic skills of individuals (in case of nutrient deficiency symptom analysis) which may be subjective and erroneous, and are unlikely to be within the reach of extension agents, much less the farmer. For example, using the nutrient deficiency symptoms expressed by plants (leaf colour and burns) as a guide to making soil fertility management decisions may lead to misdiagnosis. Deficiency symptoms may be caused by various mineral nutrients and other stresses such as moisture stress, water logging, and pathogens. Establishing field test strips to test different mineral fertilisers over a cropping season so as to assess the most limiting nutrient is time consuming and labour intensive, expensive, and requires that the right type of fertiliser should be available for the farmer in small quantities. If farmers wish to try out this method, the availability of the right type of fertiliser may be a limiting factor since fertiliser retailers may force farmers to buy what is available on the market rather than what they actually need. Health hazards may also arise as a result of improper handling of various retailed fertiliser packages. Attanandana and Yost (2003) indicated that, even though soil testing is an important tool for preparing site-specific fertilisers, it is very little used by Thai farmers because of the lack of supportive research, the costs of soil analysis, and the limited capacity of this test kit for soil analysis. Using soil test kits such as potable colorimetric test kits where filtered extractions of soil samples are subjected to reagents to obtain specific colour reactions that are read through a colour chart has major limitations:

- Representativeness is a problem because small amounts of soil are used in samples;
- Farmers may use expired reagents or may not have the financial means to constantly buy reagents;
- Some soils that undergo oxidation may interfere with the colour developments in the extracts (TSBF-CIAT, 2009);
- Economic realities and time limitations (labour, travel) may limit small farmers' access to soil laboratory analysis. Laboratories for soil analysis in Cameroon are barely equipped.

Given these limitations, TSBF-CIAT recommends that field testing, farmer diagnosis of fertiliser needs, and soil analysis should be done only where field conditions are anomalous. The issue of whether or not fertilisers will be manufactured to suite the soil condition of each farmer remains unanswered. As explained earlier, even though farmers' fields may have the same or similar soil conditions, farmers grow different crops in various combinations that respond differently to fertiliser applications, which will influence soil nutrient balances. Recognising the difficulties entailed in developing Integrated Soil Fertility Management strategies for cassava-based systems, TSBF-CIAT recommends that research efforts be directed first toward establishing fertiliser requirements and accompanying strategies for cassava before formalising and disseminating them as extension information. They propose that candidate Integrated Soil Fertility Management practices and accompanying diagnostic tools for improved fertiliser and organic resource management should be the main focus. The question that remains unanswered is: Is the use of fertiliser really necessary or desirable?

4.7.5.4 Reasons for fertiliser use and non-use in the study villages

Some 83% and 90% of Koudandeng and Malende farmers, respectively, do not use chemical fertilisers and yet obtain adequate yields. Despite the resilient nature of cassava polyculture fields, 15% (five) of the farmers in Koudandeng indicated that they apply NPK (20:10:10) fertiliser on their cassava fields. Koudendang farmers who use fertilisers reported that they confront problems of land scarcity and thus fallows are reduced to one year. This implies that increased intensification and sedentarisation of production may lead to the need for the use of fertilisers among farmers who face problems of land scarcity. Ten per cent of Malende farmers reported that they applied fertilisers in their cassava-based polyculture fields and this was mainly confined to the cassava HYVs (agric tall branching and agric short branching) that they grow. Some farmers also said that they grow cassava in fields in which tomato was previously planted to take advantage of the fertilisers applied on the tomato. Only one farmer indicated that he applied fertiliser on all of the cassava varieties that he grows.

Farmers have multiple financial responsibilities and depend mostly on the sale of their agricultural produce for cash income, which may not meet all of their financial needs. Investing in fertiliser is an additional expenditure that increases farmers' financial burdens, whereas traditional soil fertility management practices do not require cash expenditure.

The few Koudandeng farmers who used fertilisers on their cassava polyculture fields indicated that the cost of the 20:10:10 NPK that they used ranges between 2.1% and 3.8% of total input costs (fertiliser and labour). The total amount spent on fertiliser ranged from 750 F. cfa to 1200 F. cfa, equivalent to US $ 0.50 to $2 considering that the exchange rate is 600 F. cfa per US dollar. Farmers buy fertilisers in only very small quantities, considering the fact that a bag of 50 kg NPK fertiliser costs at least US$ 25 in Yaoundé and Douala (the main cities of Cameroon). This price is higher (about US$ 45) in the provincial towns and rural areas. The few farmers who use fertilisers on their polyculture fields spend less than US $2 per field, but this may not be sufficient. In Malende, the two male farmers who cultivate cassava HYVs in monoculture spent between 125.000 f cfa and 150.000 f cfa (US $208 to $US 250) on NPK fertiliser (composition 20:10:10) per field. This is relatively high compared to the less than US $2 that farmers spend on cassava-based polyculture fields in Koundandeng. One of the reasons that Koudandeng farmers do not accept cassava HYVs is that, to have high yields, fertiliser must be used, especially after three successive plantings (see Chapter 5).

If farmers decide to apply fertilisers, then the traditional land tenure systems presents a limiting factor for women and landless farmers. Traditionally, land ownership and control rights are ascribed to men, while women have usufruct rights to land for food crop production either through marriage or through their natal kin. Women may have to seek authorisation from their husbands or male kin before applying fertilisers on their fields. Women's option for fertiliser use therefore depends on men's decision making, which may be influenced by their perceptions of fertiliser. In a focus group discussion on gender access to land resources and fertiliser use in Koudandeng, some prominent responses were:

> I am divorced and I came back to my own family. My brothers accepted me and have given portions of our fathers' fields for me to grow my food crops on. Moreover, why do I have to spend money to improve the fertility of land over which I do not have ownership? (Sabine)

> I work on my fields, but if I have to apply fertilisers to or sharecrop out or give out some portions of this land to my friends, sisters or any woman in the village, I must ask my husband because he owns this land. The land belongs to me because I am his wife. (Mama Marie)

> I am in my second marriage and, when I left the first marriage, I did not bring any land along with me. I have no right to take important decisions on my food crop fields because the land belongs to my husband. If I am divorced today, I will leave the land and the most I can do is either to sell my crops in the fields or leave the crops for my children. The children are his; I did not come here with any child. (Celine)

Traditional cassava-based polyculture systems and farmers' soil fertility management strategies reduce the need to acquire more farmland to grow individual companion crops in monoculture, which is especially important in those cases where land scarcity is becoming a problem. In Malende, where land is increasingly commoditised, landless farmers seek to maximise output from rented land without using soil improvement techniques, while the landowners are interested in maximising income from land rental and so do not care much about soil fertility improvement:

> I have lived here for eleven years. The general practice is that land is rented out for a period of two years and renewability of the contract depends on the landlord and the productivity of the land. If my yields are not encouraging, I simply abandon the land and look for another piece of land to rent. The soils here are volcanic soils and thus fertile, and so one can continuously work the same piece of land for four to five years before abandoning it. Why should I improve the soil when I have no right to and, moreover, when a landowner realises that one has used soil improvement techniques and had high yields, they decide to increase the price for the next year so as to push you out if you are not willing to pay the new price. After all, the land will be rented by some other person at the price for which it is being offered. (Susan)

In this section, it is argued that traditional soil fertility management practices do not require cash outlays. Greater use of fertilisers will increase farmers' financial burden due to the costs entailed, make it necessary for them to acquire more farmland in order to grow individual crops in monoculture, and entail high costs for women and landless farmers due to the limitations imposed by traditional land tenure regimes.

4.7.5.5 Future agrochemical markets and vulnerability

Agrochemicals based on fossil fuels and phosphorus (rock phosphate) are expensive and are very likely to become more expensive in future as oil and phosphate rock supplies diminish relatively, accentuating what occurred during 2005-2008 when fossil fuel prices, nitrogen fertiliser prices, and phosphate rock prices skyrocketed (Howard et al., 2008). Chemical fertilisers based on natural gas and phosphates will become less affordable and less accessible. The affordability of agrochemicals will be a problem for farmers who may become dependent on synthetic pesticides, herbicides, and fertilisers, especially when they cultivate HYVs. HYV monoculture will make farmers dependent on fertiliser use, which presents problems of increasing costs, and makes their farming systems highly vulnerable to extremely volatile world market prices for agrochemicals.

Farmers may also be tempted to use what is available on the market and not what is actually required because small traders may not provide the fertilisers that respond to individual farmer needs, which will lead to greater soil nutrient imbalance and therefore to other associated risks. Even when the right type of fertiliser is available, farmers' choice of which fertilisers to use will depend on their financial means and knowledge of the implications of applying the right fertiliser dose or not.

AGRA's strategy for improving input delivery to smallholder farmers through agro-dealers is not clearly laid out. Two issues are at stake: whether fertilisers will be developed to meet farmers' microniches, and what strategies might be put in place to ensure that agro-dealers sell the right type of fertilisers to farmers without escalating prices. The question of which category of farmers will participate in the fertiliser manufacturing process (if they do at all), as AGRA proposes, is yet to be answered.

In summary, if farmers become dependent on synthetic pesticides, herbicides, and fertilisers, rising prices of those agrochemicals that are manufactured based on fossil fuel and rock phosphate will limit their affordability. The lack of access to the right type of fertiliser mixes alongside high costs will make traditional farming systems vulnerable and thus less sustainable.

4.7.5.6 Health hazards associated with chemical fertilisers

The difficulties involved in the efficient estimation of soil nutrient balance, the use of chemical fertilisers that are available on the market rather than what is actually needed, and wrong fertiliser dosage may lead to heath hazards due to the effects of chemical residuals (high concentrations of chemicals in the above and below ground edible parts of crops) on companion crops. Also, increased incidence of pests in monoculture fields may lead to the use of pesticides and herbicides, which may have direct effects on farmers' health as well as residual effects (high concentrations) on crops. Improper use and disposal of containers may also present health hazards for other household members. For example, the two men who either used herbicides or fungicides in Malende said that they applied the products that are intended for their cocoa and oil palm fields on their cassava-based polyculture fields. Previous research (Nchang Ntumngia, 1997) in this village showed that some women used chemicals that were meant for use on their husbands' cocoa fields to solve the pest and disease problems that they faced in their cassava polyculture fields. Agrochemicals that are used for spraying cocoa pods are obviously of a higher concentration and are not adequate for use on legumes, root and tubers crops, and cereals.

4.8 Risks of Promoting a Shift from Polyculture to Monoculture

Promoting the use of chemical fertilisers may lead to a shift from polyculture to monoculture, which may undermine traditional agroecological systems and their benefits without providing compensating benefits over time. As pointed out at the beginning of this chapter, while emphasising the use of fertiliser to increase cassava yields, TSBF-CIAT acknowledges the fact that Integrated Soil Fertility Management (ISFM) strategies that are appropriate for cassava-based polyculture fields in the humid tropics have not yet been developed. However, it argues that investments in cassava production offer huge potentials because significant gains in productivity are likely, and cassava and its intercrops are important staple foods and cash crops. It argues that efforts should be directed first at establishing fertiliser requirements and accompanying ISFM practices, which should focus on developing candidate practices and the accompanying diagnostic tools for improved fertiliser and organic resource management. This argument suggests the relative ease of applying fertilisers on monoculture fields compared with polyculture fields.

To date, generally speaking, the use of chemical inputs has led farmers to convert polycultures fields to monoculture to facilitate the process of agricultural intensification. The use of chemical inputs to increase yields is based on the need for large scale, homogeneous production for the market, and requires the existence of a set of homogenous inputs and the application of Western industrial and scientific agronomic principles, which have led to the rapid transformation of traditional farming systems in many world regions. Cases of conversion from traditional polyculture systems to monoculture have been extensively reported, e.g. in Latin America (Altieri, 1999), India (Singh, 2000), as well as across Asia (Cassman and Pingali, 1995; Shiva, 1991). It is argued that monoculture makes its easier for governments to tax farmers' produce as well as to exploit farmers' surpluses. Based on these past experiences, the difficulties posed by combining fertilisers and organic matter management practices to improve crop productivity in cassava-based polyculture systems could lead to a shift to monoculture. Such a shift leads to the risks discussed below.

Cassava monoculture will facilitate the calculation of soil nutrient balances and fertiliser requirements and permit recommendations to be made regarding the amount of fertiliser to be applied to obtain higher yields. Given the large farming population and the diversity of their fields and soil types in Cameroon, a question that is yet to be answered is whether these calculations will be done and recommendations made for each farmer's field, or instead these will be mass calculated for all farmers or field types within a given region. Making generalised recommendations for fertiliser use will further compound rather than resolve the problem of dealing with individual farmer's field niches and under-and over-application of fertilisers.

A shift away from cassava polyculture systems to monoculture is likely to require a change in the nature of the farm implements used. Farmers may not be obliged to stop using hoes, cutlasses, and axes when establishing monoculture fields, but the fact that they have to cultivate many such fields to plant the various companion crops that are all found in a single polyculture field may mean that heavy equipment such as tractors and chainsaws must be used to overcome labour constraints. Mechanisation leads to deep soil tillage and thus losses, and increases the rate of water percolation. Ickowitz (2004), in her study of the economics of shifting cultivation and deforestation in Cameroon, argues that, even though the use of machetes in land clearing may be labour intensive, it may be more efficient than the use of machines on tropical soils. The greatest changes in soil physical properties occur during the process of mechanical clearing. Numbem (1998) stated that mechanical soil tillage loosens soil particles and increases the rate of erosion through leaching compared with low or no-till, which is characteristic of the shifting cultivation systems of traditional farmers of southern Cameroon.

Increased soil nutrient depletion through leaching may arise as a result of a shift from light to heavy agricultural implements or mechanisation. The rapidity with which groundnut and egusi cover the soil surface in cassava polyculture systems, thus reducing the amount of nutrient loss through leaching, has been discussed earlier in this chapter. If cassava monoculture is encouraged to facilitate the use of fertiliser and HYVs, then the length of exposure of cassava monoculture fields to heavy rain will be longer relative to cassava polyculture fields. As such, the rate of depletion of farmers' soils will be higher because the rate of percolation of water is high and water-soluble nutrients are leached from the topsoil, especially in the case of Koudandeng, whose soils are highly permeable (refer to the section on soil composition).

According to farmers, it takes approximately four months after planting for the leaf canopy of short branching cassava varieties to be formed, which protects the soil surface from heavy raindrops. Tall branching and non-branching varieties take longer to produce thick leaf canopies. Leihner (2002) reports that, in cassava monoculture, cassava's late canopy formation and soil coverage increases soil erosion compared to other crops. Also, high nutrient leaching will lead to a more negative nutrient balance and therefore fertiliser requirements will increase, which raises further issues of affordability and also of equity, since women and landless farmers do not have the liberty to apply fertilisers on fields without the consent of husbands or landowners.

Mechanisation also implies deforestation. Farmers' traditional method of land preparation for crop production involves bush clearing and felling of trees, raking, burning, and tilling or mounding. Large trees that cannot be felled and tree trunks that cannot be removed are left in the fields to provide wood and microsite niches for specific crops. Mechanisation will alter this, which will have consequences for the environment since the field has to be kept free of any obstruction to facilitate tractor movement. Extensive deforestation will also be a major consequence of mechanisation because the fields will be kept permanently under cultivation. Farmers will be obliged to use heavy and expensive equipment such as chainsaws to fell trees and cut them into pieces to facilitate removal. As such, those who can afford the use of chainsaws will establish larger fields relative to their present fields. Mechanisation is likely to create environmental and soil infertility problems, as well as generate inequities.

The role of trees in improving soil fertility where roots extract nutrients below the root zone and made available at the top soil through leaf litter, decay, and burning has been discussed earlier in this chapter. The absence of this process of nutrient recycling when fields are put under mechanisation and permanent cultivation will further impoverish the soils as well as make farmers dependent on fertilisers to obtain high yields.

Some of the trees and forest products that are found in farmers' fields and the forest constitute a source of income for farmers. Timber is sawn into planks and either sold or used. Farmers, especially women, collect and harvest non-timber forest products such as *njangsa* (*Ricinodendron heudolotti*), bitter cola (*Garcinia cola*), eruh (*Gnentum africanum*), bush mango seeds-locally called *ogbono* (fruit of *Arvingia gabonensis*) and fruits (African plum-*Prunus Africana or Pygeum africanum*, mango, orange, avocado pear) for consumption and sale. Deforestation will eliminate such economic activities and therefore a livelihood for farmers.

Monoculture also increases the risk of exposure of the cassava monoculture fields to pests and diseases thus leading to an increase in their incidence. The low incidence of pests and diseases in polyculture fields compared to monoculture fields has been widely cited in the literature (Altieri and Letourneau, 1982; Altieri and Liebman, 1986; Altieri, 1995; Vandermeer, 1988, 1995). Also, the different crop and trees in cassava-based polyculture fields have differential degrees of susceptibility to pests and pathogens. This enhances the abundance and efficiency of natural enemies that limit the spread of pests and diseases. Monoculture will eliminate the host plant/predator relationship and provide a microclimate that is suitable for the spread of pathogens (fungi and nematodes) and pests. An investigation into the crops that serve as hosts for natural enemies (predators) for pests and pathogens in cassava polyculture fields was beyond the scope of this research. However, farmers' evaluation of the severity of the pests and diseases that they face in cassava production ranged from low to medium. The main problems cited in Malende were i) curly leaf disease (locally known as jelly coil) caused by the African Cassava Mosaic Virus (ACMV), the Cassava Green Mite pest (AGM), and root rot disease, whereas Koudandeng farmers indicated that the most severe problems were root rot disease and attack by red ants locally called kamsi. It might be that the severity of these pests, diseases, and viruses would be higher if only cassava were planted, especially those varieties that are said to be highly susceptible. Other pests and diseases that are not evident in farmers' traditional polyculture fields are likely to become evidence under monoculture. Monoculture, especially of homogenous crops such as cassava, increases the risk of spectacular crop failure, and therefore can have negative consequences for farmers' diets and food security. See Chapter 6 for a detailed discussion.

Farmers' combination of short- and long-growth cycle crops reduces both the amount and the cost of labour required for weeding cassava-based polyculture fields. For example, the 23% of Malende farmers who hired labour for weeding reported that it was used only for the third weeding. All crops require careful weeding in the early growth stages. Weeding is also done during groundnut harvesting. It costs 20.000 F cfa ($33.30 US dollars) to weed one hectare. Planting in polyculture therefore allows farmers to save at least 20.000 F. cfa that would be spent for a second weeding (corresponding to the groundnut harvesting period) had groundnut not been used as a companion crop. Furthermore, the rapid spread of egusi vines covers the soil surface and reduces the amount of weeds in cassava-based polyculture fields, which in turn reduces the number of times weeding must be done and its costs. In Koudandeng, only two farmers (6%) paid to have their cassava polyculture fields weeded because they fell ill.

In conclusion, despite the technical and practical difficulties entailed in combining chemical fertilisers and farmers' traditional organic matter and vegetation management practices to increase production and productivity in traditional cassava-based polyculture systems, the Cameroon Government, AGRA, and international and regional research institutions continue to promote the use of such inputs to achieve the expected gains in productivity. However, based on past experiences in Asia and elsewhere in the world, it is argued that this may lead to a shift away from traditional polyculture farming systems toward monoculture systems to facilitate intensification based on agrochemicals and HYVs. The intended and unintended costs of this shift might undermine traditional agroecological systems and their benefits, without providing compensating benefits over time. Some of these costs may include:

i. Generalised recommendations for fertiliser use due to the ease of estimation of the levels of soil nutrient balance and optimum fertiliser requirements will lead to under or over-application of fertilisers.
ii. A shift to monoculture is likely to lead to the use of heavy equipment such as tractors and chain saws, which may replace the hoe, machetes and other small farm implements. Various risks are associated with agricultural mechanisation:
    a. Deep soil tillage and thus losses,
    b. Increased exposure of fields to heavy raindrops and increased rate of water percolation and therefore soil erosion and soil nutrient depletion through

leaching (especially in the case of Koudandeng, whose soils are highly permeable),

c. An increasingly negative nutrient balance due to high nutrient leaching, which will lead to an increased fertiliser requirements;

d. Increased fertiliser requirements will raise further issues of affordability and equity for women and landless farmers due to the traditional land tenure systems;

e. An alteration in the traditional method of land preparation where fields have to be kept free of obstructions to facilitate tractor movement and permanently under cultivation. The consequences of this process of deforestation are environmental and soil infertility problems, the absence of nutrient recycling through trees, increased dependence on fertilisers to obtain yields, elimination of related economic activities and therefore of livelihoods that are dependent on trees forest products and on the forest, and the generation of inequities among the rich and poor farmers.

iii. Increased risk of exposure to pests and diseases due to the elimination of the host plant/predator relationship and of microclimates that are suitable for the spread of pathogens (fungi and nematodes) and pests. This results in an increase in the incidence of pests and diseases.

iv. An increase in the risk of spectacular crop failure, which can have negative consequences for farmers' diets and food security.

v. An increase in the amount and the cost of labour required for weeding.

4.9 Conclusion. Dangerous Assumptions: AGRA, Agrochemicals, and Cassava-based Polyculture

Traditional cassava-based polyculture fields are multi-layered and multi-species, with complex temporal and spatial configurations where myriad crops are grown. On average, a six to seven different major and minor crops is planted per field, and on average three cassava-based fields are planted per household per year, where each is likely to contain different combinations of species. Such fields are either established in newly cleared secondary or primary forests, in cleared fallow vegetation fields, or in swamps or marshy areas. The term 'overlapping patchworks' is an apt description of the varied sizes, distribution, and composition of these fields.

While cassava-based fields constitute women's main food crop fields in Koudandeng, both men and women manage them in Malende. Farmers seek to combine crops in these fields to achieve food security (among other goals, as discussed in Chapter 6), weed suppression, soil improvement, and nutrient balance between crops. These microniches undergo continuous development and change due to the variation in the spatial and temporal configuration of crops that respects specific ecological processes and principles such as nutrient recycling, facilitation, and complementarity, and that reduces competition among intercrops and ensures weed control. This spatial and temporal co-occurrence of the different crops and varieties exhibits shared environmental requirements and ecological interference, which reflects the ways in which farmers consider and combine aspects of crop autoecology and synecology.

The assumption that *per capita* food production in Africa is declining implies that crop yields in traditional African farming systems are low. This idea is contested based on the argument that small-scale African farmers' main objective is to ensure sustainable livelihoods rather than to increase productivity and maximise profitability on the basis of specific crops (see also Chapter 6). Farmers therefore grow a diversity of crops in their polyculture fields. This as well as other studies highlight the fact that aggregate yields (overall output) of all of the companion crops in polyculture fields are higher than the yields of individual crops when grown in monoculture using the same planting density per unit area of land. The difficulties entailed in estimating (measuring and standardising) the yields (often obtained through piecemeal harvests) of all companion crops in a polyculture field together often leads to the use of yield data for reference or single crops species, which are then used to evaluate traditional polyculture fields.

The major problem with this method of estimation is that measuring the yields of single and reference crop species (as is often done by government researchers in Cameroon) underestimates the performance or productivity of farmers' polyculture fields and the yield values obtained are only partial estimates. Comparing partial yields of polyculture fields with the yields of individual crops that are either grown in monoculture in farmers' fields or in high potential areas such as researchers' fields, leads to policy recommendations that do not reflect reality. Furthermore, the choice of which reference crops to use often depends on researchers' subjective judgements rather than on those of farmers, whose evaluation criteria include the performance of all companion crops combined. Measuring yields of single crop species is inappropriate in circumstances where a diversity of crops is intercropped. It is proposed that, using the notion of land equivalent ratio (LER) as the guiding principle, aggregate yields of all companion crops for a given time period in a given space should be used to assess the productivity of traditional polyculture systems. This will avoid incorrect judgements and therefore wrong policy recommendations.

In arguing against the assumption that African soils are naturally poor and are therefore not suitable for agriculture, this study concludes that Cameroon has a range of soil types and ecologies and that, over much of the country, and particularly in the South, are suitable for the crops that are grown. Malende and Koudandeng soils have good physical properties and medium to rich chemical composition, favourable relief, high vegetation cover, and good agro-climatic conditions (soil temperature and moisture, precipitation, and solar radiation), which determine their high agricultural potentials. In relation to their chemical composition, Koudandeng and Malende soils have a moderate to high cation exchange capacity, moderate rate of loss of soil organic matter, clay particles and water soluble minerals through leaching, near neutral soil acidity level, which does not impair the availability of nutrients and does not facilitate aluminium toxicity, a medium to high soil CO_2 concentration, and a slower process of ferralitisation due to the higher soil pH level in the case of ferrasols. They also have a high concentration of the bulk of all available plant nutrients in the upper 0-50 cm, which corresponds to the root zone for nutrient uptake. They have good soil physical properties: moderate to well drained with medium to high available water storage capacity; they are deep, highly permeable, and have a stable microstructure and are therefore less susceptible to erosion, have fine pores and are friable and slightly sticky consistency, which makes them easy to work with the hoe. They fall with the Isothermic soil temperature regimes and have an average annual soil temperature range from 24-28˚C and the udic moisture regime where their soil moisture content is high, and the soils are not dry for 90 cumulative days in a year. The soils have high vegetation cover which, when cleared and burned during land preparation, releases a stack of nutrients and increases the availability of soil phosphorus, exchangeable calcium and magnesium and the pH level and base saturation of these soils. Unlike all other types of ferrasols, phosphorus fixation is not a major problem in Koudandeng soils that are classified as haplic ferrasols.

The high agricultural potentials of these soils makes them suitable for growing cocoyam, yam, cassava, taro, sweet potato, groundnut, maize, tropical vegetables, rubber, oil palm, banana and, to a lesser extent, cocoa, robusta coffee, and tea (grown at higher elevations). These soils cannot be considered as poor. Therefore, the null hypothesis that all Cameroonian soils are poor and thus require the use of fertiliser to improve crop yields is rejected. Furthermore, all of the factors that determine the agricultural potentials of an environment should be considered as a whole when making agricultural suitability judgements and soil fertility improvement recommendations. The argument that African soils are naturally poor and are mined with little or no chemical fertiliser used focuses attention on the chemical composition of soils, while neglecting other important factors.

Contrary to the assumption that African soils are mined and thus unsustainable, the findings of this study also indicate that Malende and Koudandeng farmers' soil fertility management strategies enable an efficient and optimum management of nutrients without the use of external inputs. These strategies are adapted to, and adapt, agroecological conditions using natural processes and inputs to maintain soil fertility. Optimum management of nutrients is obtained through i) the association of nitrogen-fixing and non-nitrogen-fixing crops, ii) efficient management of landscapes through the spatial and temporal distribution of crops to reduce nutrient competition, maximise the efficient use of water and light resources, modify the crop environment to facilitate the growth of companion crops, and reduce the rate of nutrient loss through leaching and erosion. The criteria for companion crop selection include individual crops' ability to adapt to specific soil conditions, the differences in nutritional requirements and absorption efficiency of different crops, facilitation of nutrient uptake and avoidance of competition for nutrients. Farmers therefore grow long- and short-cycle crops as well as companion crops that can tolerate similar soil conditions. Planting density is also determined by the meaningfulness of each companion crop to farmers. Compared to the individual crop populations in monoculture, the population of each companion crop is lower, which also reduces the amount of nutrients extracted by individual crops.

The results presented in this chapter counter conventional wisdom, which poses that shortened fallow periods due to increasing human population densities are a main cause of soil infertility and declining crop yields, which has led to the promotion of fertiliser use as a main recommendation for crop yield improvement. It is argued that, if fallow periods have decreased in the relatively distant past, they now appear to be increasing in the study area. Fallow lengths are varied and depend on farmers' production orientation (subsistence versus commercial), socioeconomic attributes (age, level of education), agroecological practices (fertiliser use or non-use) and characteristics (field location), and farmers' perceptions (evaluation of soil fertility). As discussed earlier, the fact that age, field location and, to a lesser extent, education are important determinants tends to indicate that labour constraints are better explanations for the lengths of fallow compared to population pressure.

Further, it is argued that short fallow fields are not actually poor in chemical and physical properties as purported, and reduced fallow length does not necessarily imply a 'breakdown' in soil fertility. Ignorance about the shortened fallow-yield relationship in cassava-based polyculture systems has led to misjudgement of the fertility of fallow fields. The type and diversity of fallow vegetation cover modifies soil characteristics and can maintain or improves soil fertility. The invasion of fallow fields by *Chromolaena odorata* enhances soil nutrient availability through rapid soil coverage and high litter and biomass production that is returned to the soil when cleared and burned.

If soils in shortened fallow fields are low in nutrients, farmers adopt a series of strategies to improve their fertility and obtain good yields through: i) the management of vegetation cover through slash-and-burn, where burning increases the soil pH, the amount of basic cations and the level of cation exchange capacity (CEC); ii) preferential placement of crops in microsites according to their specific nutrient requirements; iii) preserving meaningful herbaceous plants, shrubs, medicinals, and fruit trees during land clearing, burning, and weeding, where these agroforestry practices can be classed as the 'principle of the fertility economy of trees'; iv) planting cover crops and legume trees; v) practicing crop rotation and succession based on the perceived nutrient requirements of each crop or crop association and the nutrient extraction of the previous crop(s); and vi) associating specific types of crops with fallow fields of specific ages to suit biophysical and phenological needs. Farmers grow annual crops in short fallow fields and semi-annual crops in long fallow fields.

It is argued here that farmers will be encouraged to reduce fallow lengths if they decide to use chemical or mineral fertilisers. The assumption that soils are mined without replenishment is rejected because it implies that soil nutrients are extracted through harvest with no returns to the soil. Incorporating crop residues into the soil is one soil fertility improvement strategy that farmers use. It is argued that not all of the plant parts (above ground and below ground) are taken out of farmers' fields and a reasonable amount of nutrients are returned to the soil in the form of crop residues (biomass), an aspect that is neglected in policies and interventions that promote fertiliser use. The amount and type of nutrients extracted depend on individual crop density, crop growth rate and yield, and crop diversity and combinations. It is well established that lower amounts of nutrients are extracted in polyculture fields relative to monoculture fields. Crop diversity and succession in a polyculture field influence the amount of residues that are returned into the soil and therefore the amount of nutrients that are recycled.

The temporal combination of crops in polyculture fields facilitates continuous, high and fast rates of nutrient recycling compared to monoculture fields and therefore nutrient deficiencies in polyculture fields are unlikely to go beyond the threshold levels that are required for crop growth. Selective weeding (where herbaceous plants and shrubs are pruned), mulching using weeds and crop residues, and combining crops that facilitate rather than compete for nutrients are other nutrient recycling options that farmers use.

It is argued that continuous cropping without such nutrient recycling will lead to the rapid depletion of soil nutrient stocks, as well as of soil carbon. The argument, then, is that policies and interventions that emphasise the use of fertilisers can undermine traditional agroecological systems and may not provide compensating benefits over time. Using fertilisers in traditional polyculture systems has technical and practical limitations. Optimum fertiliser requirements for individual crops are based on estimated soil nutrient balances that are calculated using nutrient inflow and outflow data, and are therefore faulty or partial due to the difficulties involved in the calculations. These difficulties include: i) the neglect of certain factors that are either judged to be less important or are difficult to estimate, ii) the use of average values rather than site- and time-specific data, which lead to either an under-estimation or over-estimation of actual crop uptake efficiency and the amount of soil nutrient input; and iii) using optimal values for crop yields based on reference crops that are grown in monoculture and under researchers' conditions. Factors that are often neglected in such calculations include: the differential patterns of response to various nutrients on the part of companion crops, the amount of nutrient loss through erosion, which depends on the variation in the intensity and frequency of rainfall, the amount of eroded soil and atmospheric deposits, the continuous deposits of fluvial and runoff water debris, and the recycling of nutrients through crop residues. Partial estimations of soil nutrient balances will lead to incorrect technical recommendations whose consequences are varied and range from low crop yields in the case of excess nitrogen application, to increased depletion of some nutrients, to increased costs due to wasted fertilisers.

It is proposed that a more holistic approach to the calculations of individual farmers' fields' soil nutrient balance must be applied if adequate recommendations are to be made regarding fertiliser use. The practical limitations of using fertilisers in cassava-based polyculture fields include: the inexistence of appropriate fertiliser mixes for polycultures and unknown nutrient requirements of polyculture systems; the inappropriateness of AGRA's knowledge-intensive Integrated Soil Fertility Management and soil testing approaches for small-scale African farmers; the possible reduction in fallow lengths as fertiliser use increases, which may have implications for the sustainability of traditional polyculture systems; the high prices of agrochemicals and vulnerability of traditional farming systems to the fluctuations in agrochemical markets; and risks to health from high concentration of chemicals in crops. Given these limitations, the need for and desirability of fertiliser use is questioned. It highlights the fact that, if fertilisers are desirable, then a major challenge is to manufacture fertilisers that suit each farmers' soil and cropping conditions. Traditional soil fertility management practices do not require cash expenditures, and fertiliser use will increase farmers' financial burden, possibly necessitating acquisition of more farmland for growing individual crops in monoculture, and entailing high costs for women and landless farmers due to the constraints imposed by land tenure. If fertiliser use becomes an option, then, traditional farming systems may become vulnerable and thus less sustainable.

It is thus argued that the guidingprinciple behind the promotion of increased fertiliser use by the Cameroon Government, AGRA, and research institutions is based on the utilitarian principle of more efficient use of inputs to increase productivity. Past experiences in Asia and elsewhere have shown that market-based agricultural intensification often leads to a shift away from traditional polyculture farming systems toward external-input based monoculture systems. The costs may outweigh the benefits. Some of these costs may include: i) further compounding rather than resolving nutrient problems in micro-niches, leading to under- or over-application of fertilisers; ii) mechanisation of agriculture with its associated risks; iii) increased pests and disease incidence due to the elimination of host plant/predator relationship; iv) increased risk of spectacular crop failure; and v) an increase in the amount and cost of labour required for crop management such as weeding.

CHAPTER FIVE
FARMERS' UNDERSTANDING OF CASSAVA VARIETIES AND IMPLICATIONS FOR THE ACCEPTANCE OF HIGH-YIELDING CULTIVARS

5.1. Introduction

Cassava is one of the major crops targeted for improvement by both the Alliance for a Green Revolution in Africa (AGRA) and the Government of Cameroon. This chapter discusses the general assumptions behind AGRA and the Cameroon Government's cassava improvement and dissemination programme, and contrasts these with farmers' varietal knowledge, perceptions, and actual cassava diversity in the study villages. The chapter first of all examines the major hypotheses and arguments against the assumptions behind AGRA and the Cameroon government policy in relation to cassava and relates these to a discussion of the importance of local cultivars and farmers' local knowledge, varietal preferences and what they grow, which raises concerns about cassava diversity. The assumption that high yielding cassava varieties out-perform traditional varieties is critically examined, particularly by focusing on the farmer socioeconomic and demographic attributes that are statistically significant in explaining the variation in the varieties freelisted and the varietal attributes that seem to order the classification of these varieties across different farmer sub-groups. It is hypothesised that farmers' preferences for traditional varieties are related to cultural factors and social relations (especially culinary traditions, use values, social status and religious beliefs), and to needs for income and to existing labour availability. It is argued that cassava farmers' primary objective is not to increase production, which is promoted by AGRA and the Cameroon Government, but rather to ensure a subsistence livelihood and meet cultural needs. Therefore, it is rather a combination of factors that determines farmers' varietal perceptions and use, which contributes to the maintenance of greater cassava diversity and non-adoption of HYVs. Rather than representing a major boon to farmers, it is argued that the HYVs are not appropriate for traditional communities and thus further dissemination of HYVs may represent a threat to cassava diversity, cultural values and livelihoods.

The spread of the HIV/AIDS pandemic, which is speculated to lead to the loss of intergenerational knowledge (Barnett et al., 1995; Haddad and Gillespie, 2001) and thus impact interspecies diversity among rural communities (Barnett and Blaikie, 1992; Rugalema et al., 1999; Haddad and Gillespie, 2001; Loevinsohn and Gillespie, 2003; Muller, 2004; Nguthi, 2007; Misiko, 2008; Niehof and Price, 2008), may also have significant implications for cassava varietal diversity. The implications of the spread of HIV/AIDS on agriculture and rural livelihood and subsistence have been empirically little documented with respect to intergenerational knowledge in farming (Fagbemissi and Price, 2009) and interspecies diversity and household dietary diversity (Akrofi et al., 2008). It is important to note that the impacts of an epidemic such as HIV/AIDS on crop intra-species diversity and intra-generational knowledge of a rural farming community becomes visible only over time and are difficult to measure in cross-sectional studies (Wiegers, 2008; Niehof and Price, 2008). The empirical findings contained herein suffer from these same limitations.

The chapter begins with a presentation of the hypotheses and arguments, and then moves to a discussion of the methods used in section 5.3, which includes a presentation of the sampling procedure, a discussion of the application of the cognitive and linguistic data collection methods that were used for data collection, and a description of how the data collected were analysed, and the limitations encountered in applying the methods and analysis. The results are presented in section 5.4 and are based on: i) a presentation of the characteristics of the sample population studied, ii) a discussion of the vernacular varietal names and farmers' logic of naming their cassava varieties. Understanding how farmers name cassava varieties is a prelude to an analysis of cassava diversity in the study area, iii) a discussion of cassava varietal salience and knowledge, iv) a discussion of farmers' varietal evaluation systems and the attributes that order the way farmers perceive their varieties, v) a discussion of intra-cultural variation in varietal salience, knowledge and classification systems and attributes across different farmer socioeconomic sub-groups, and vi) a discussion of cassava varietal diversity and the factors that influence diversity. The chapter ends up with a discussion that relates the findings to the hypotheses set and the existing literature.

5.2 Assumptions and Hypotheses

The main assumption for promoting the selection, breeding, and dissemination of improved cassava varieties is that farmers' local varieties are not high yielding and are highly susceptible to pests and diseases as compared to the improved varieties. AGRA argues:

> Traditional African crop varieties are not high yielding and so the use of better seeds and high yielding varieties and related effective technologies would reduce or eliminate inefficiency in production systems and the risks of food shortages. Improved crop varieties should allow farmers to increase yields for consumption or for sale, reduce exposure to crop failure through improved resistance to local stresses, and lead to reductions in the cost of food for all (AGRA, 2006).[16]

The hypotheses related to this that are tested in this chapter are:

i. The hypothesis is that the traditional, less ethnically diverse and more subsistence oriented Koudandeng will have more knowledge of cassava varieties relative to the more ethnically diverse and commercially oriented Malende. HYVs will be more salient and widely grown by Malende farmers compared to Koudandeng farmers.

ii. The values that farmers attribute to cassava in relation to their livelihood options (labour, land, income, subsistence), as well as cultural values (culinary, religious

[16] http://www.rockfound.org/initiatives/agra/agra.html. Accessed on 18/11/2008.

and ritualistic, status) determine the diversity of cassava varieties across different socio-economic categories of farmers in both the traditional and the more commercially oriented village under study. HYVs may not fulfil these values and therefore management of HYVs alone may not be an option for farmers relative to their local varieties.

iii. Yield and income earning may be greater determinants of diversity among more commercially oriented Malende compared to more subsistence oriented farmers of Koudandeng who may be more concerned with ensuring food security and maintaining their food habits and culinary traditions. Local varieties that meet farmers' food security and food ways will be more highly salient and the research HYVs that are bred for high yields and disease tolerance only will be less salient among Koudandeng farmers compared to Malende.

iv. As cassava is increasingly commercialised, men will know and grow mainly research-introduced varieties, whereas women's knowledge and cultivation of diverse varieties will be greater than that of men. The salience of local varieties will be greater among women as compared to men.

v. The devastating effects of HIV/AIDS on rural livelihoods may not necessarily have negative implications for intra-species diversity and intra-generational knowledge of cassava varieties and therefore cassava genetic diversity.

It is argued that if farmers' objective is mainly to increase productivity (yield per unit area) and if local varieties are actually low yielding, and then HYVs may out-compete farmers' local varieties. HYVs will therefore have a higher level of salience among farmers due to the comparative advantages that they have over local varieties. Women who are ensurers of their family nutrition continue to produce local varieties for own consumption as well as for sale despite the promotion of HYVs in research and development.

A second excerpt from AGRA indicates its commitment to the recognition of farmers' knowledge in the development and dissemination of cassava varieties:

> One of the reasons why the Green Revolution did not work in Africa was the fact that crops were bred for uniformity rather than diversity, which made the process of bringing higher-yielding seeds to Africa's small farms more challenging and complicated…because of the diverse Africa's climate, soil, and range of suitable crops as compared to Asia or Latin America…This great diversity of crops is a result of the great diversity of landscapes, soils, climates, including thousands of ethnic groups who speak no less than 800 languages and live across 53 African nations. But nearly everywhere, African peoples farm, and they have acquired a deep knowledge of both farming and the environment. While some of this knowledge has been lost, it has never been more necessary, as Africa's small-scale farmers today struggle to combine old and new technologies under harsh conditions that are dramatically different from any time in the past. To regain self-sufficient in agricultural production that African societies had not so long ago means relying on African history, knowledge and creativity and applying the best that science has to offer…Our

work begins in the fields alongside small-scale farmers, to learn from them and to understand their most pressing problems and the potential solutions.[sic][17]

Although AGRA's objective to correct the errors of the past Green Revolution by forming a partnership with small-scale farmers and especially women to draw upon their local knowledge in their breeding programmes, national and regional research institutions responsible for the development of cassava H*YVs may not improve upon their breeding strategies since no concrete methodology for* achieving this has been specified. If breeders modify their strategies to increase farmer participation, their breeding partners may be more limited to a specific category of women farmers and thus the varieties bred will not meet the needs, interests and priorities of a greater proportion of farmers. An investigation of how farmers actively participate in researchers' cassava breeding programmes is beyond the scope of this research. However, the analysis of the data collected focused on the acceptability of the research HYVs that were released between 1986 and 2002 across farmers by their significant socioeconomic sub-groups is conducted. The cognitive ethnobiology methodological protocol used for data collection and analysis in this research is an attempt to propose a procedure that can be used to systematically target and document farmers' varietal knowledge and preferences and relate these to farmer behaviour when developing new crop varieties. It is proposed that this methodology may be useful for targeting other areas of farmers' knowledge and perceptions that influence decision-making frameworks in crop improvement strategies.

5.3 Methods

5.3.1 Sampling Procedure

Respondents for the freelisting and triads testing exercises were selected from members of a stratified random sample of households that participated in the household and cassava surveys, as well as among other farmers within the two villages who were willing to participate in the exercises. The stratified random sample was selected from the total sample of households that were censused by the researcher in 2003. Given the ethnic diversity of Malende and the varied socio-economic characteristics of farmers in both villages that may influence cassava varietal diversity and knowledge, it was necessary to ensure that farmers from various social strata were included if complete knowledge of the domain was to be obtained. Limiting data collection to only members of the households who participated in the household and cassava survey may not have yielded the exhaustive list required. For example, in Malende, two native Balong speakers who did not participate in the survey research named two varieties (Old stick and Melong stick) that were not named by other persons. In Koudandeng, where cassava is mainly grown by women, men did not want to participate in the exercise because they said that it was not culturally appropriate for them to speak about women's crops. A typical response was, "cassava is a women's crop, you'd better talk to women. If you are interested in cocoa and oil palms then I would participate." The selection criteria for both the freelisting and triads tests were therefore: belonging to a household that was used for the survey research, being a cassava farmer, and willingness to participate. Likewise, it was important to ensure that HIV/AIDS affected households were

[17] http://www.rockfound.org/initiatives/agra/agra.html. Accessed on 18/11/2008

included. In total, one hundred and fourteen (114) farmers were interviewed, where 55 were from Malende and 59 were from Koudandeng. Eight farmers (14.5% of the sample) in Malende were interviewed who did not participate in the survey research. In Koudandeng, 13 farmers dropped out of the interview either because of time constraints, divorce or death, and so were replaced.

5.3.2 Data Collection Methods

The research was carried out with 114 male and female farmers (55 from Malende and 59 from Koudandeng) using cognitive ethnobiology methods that permitted the mapping of the structure of the domain of cassava varieties. These cognitive methods were judged to be more robust than other methods since they are able to capture both unconscious and conscious dimensions of farmers' understanding of cassava varieties and thus provide greater nuance and subtlety. It is argued that farmers' preferences are based on their cultural understandings (knowledge frameworks, practical experience, beliefs and social identity). The methods of data analysis that are available likewise permit sophisticated interpretation of such data.

The methodological protocol used to reveal farmer's cassava varietal knowledge and differences in knowledge of varieties by different categories of farmers and what varieties they grow was developed based on Price (2001), Borgatti (1996a, 1996b), Bernard (1995, 1996), Gurung (2002), Puri and Vogl (2005), Field (2005), and Weller (2007). The approach used several inter-related methods that provided information in their own right as well as data for subsequent data collection instruments, and were thus carried out in sequential order: i) free listing technique and follow up questions, ii) triads testing and iii) interviews. Taken as a whole, these methods are aimed at identifying cassava varieties that farmers know and use, proximities (similarities and dissimilarities) among different varieties, the attributes that order farmers' classification of their varieties and how these are related to varietal diversity, and patterns of similarities and dissimilarities among different categories of farmers with respect to their knowledge of cassava varieties and the ideas that explain the existence of these patterns. The analysis of farmers' knowledge of reseach-introduced HYVs and local varieties rests on the assumption that knowledge domains (well bounded areas of knowledge) can be documented and that this knowledge is essential to cassava diversity loss or maintenance.

5.3.2.1 Freelisting

Freelisting is a powerful technique for eliciting items in a cultural domain where there is intra-cultural variation (Bernard, 1995; Nazarea-Sandoval, 1995; Gurung, 200; Quinlan, 2005). It also permits the collection of data to be used in other data collection techniques such as triads testing and analysis techniques such as multidimensional scaling (MDS), cluster analysis and Property Fitting regression, and in comparing means across sub-samples through an analysis of variance (ANOVA). Freelisting can quickly and easily amass focused data (Ibid.).

Intra-cultural variation in knowledge of cassava varieties was studied in relation to sex, ethnicity, education level, family size, number of varieties grown, household headship, and household HIV/AIDS status. These are the socioeconomic attributes that significantly determine the variation in naming the varieties on farmers' freelists.

A total of 114 farmers (55 from Malende and 59 from Koudandeng) were asked to list all of the cassava varieties that they know, including those that they grow, have abandoned or have heard of but have never grown. In keeping with the requirements of the methodology, initially farmers were requested to freelist all varieties that they know without any prompting from the researcher. Afterward, because the objective was to get farmers to make an exhaustive list, informants were probed for additional varieties and, at times, the names of the varieties that they had listed were repeated and they were asked if they knew any more. In order to elicit farmers' explanations for maintaining or loosing cassava varietal diversity, follow up questions were asked immediately after freelisting was complete regarding which of the varieties listed did they grow during the year in which the research was carried out; why they grew specific varieties during that year; which varieties had they grown before but did not grow in the reference year; for varieties that they had grown before but were not still growing, when did they stop growing them and why; and for the varieties that they know but have never grown, how did they learn about the varieties and why have they never cultivated them.

5.3.2.2 Triads testing

Triads testing is a technique that enables differences in cognition of the items belonging to a cultural domain to be explored. Triads testing was used in this research to understand farmers' perceptions of the cassava varieties that they listed by analysing how and why they group order these varieties and to discover what dimensions farmers use to evaluate and classify their varieties. In this, identifying varietal attributes and clusters that appear to order the varieties along a continuum of attributes can help to i) identify those varieties that are at risk of disappearing; ii) identify the most meaningful varietal attributes that may be useful for breeding programmes and government interventions; iii) gain insights into the way farmers perceive which characteristics are important and how they tend to group varieties that can be compared with the varieties that they grow thus relating these to varietal maintenance based on cultivation. Knowledge of these varieties provides baseline information for understanding the relationship between varieties and farmers' agroecological niches, processing, food and food ways, food security and household economies and livelihood options (income earning, labour and land allocation) and strategies.

A triads test questionnaire to be administered for each farmer in the two villages was constructed using Burton and Nerlove's (Burton and Nerlove, 1976; Bernard, 2006) lambda 2 (λ) balanced incomplete block design (BIB) through the ANTHROPAC 4.983/X programme (Borgatti, 1996a). The $\lambda = 2$ design limited the redundancy involved and the cognitive burden on respondents by reducing the number of triads to be administered per questionnaire per farmer from 560 to 30 for Malende and from 3276 to 70 for Koudandeng. ANTHROPAC produced a randomised triads test questionnaire according to the number of informants who participated in the free list exercise. Ten varieties were used to construct the questionnaire for Malende and 15 for Koudandeng. The choice of the number of varieties was guided by the research hypotheses, which are related to management of varietal diversity and acceptability of HYVs that were introduced by local research institutions. As such, varieties were selected on the basis of salience (most and least salient), and all HYVs were selected as well as some landraces. Landraces are varieties that farmers indicated were grown by their forefathers.

Farmers were subjected to the triads test individually and were first introduced to the exercise by presenting two sets of three of the names of crops, crop by-products and animals and asked to choose the one that they thought was most different. The examples used were:

Mango	Corn	Palm Wine
Chicken	Palm Wine	African Plum

Some farmers chose palm wine in the first triads because it is a drink, while mango and corn are staple foods. In the second triads, some people still chose palm wine because it is drunk, while African plum and chicken need to be chewed; while others chose chicken in the second triads because it is an animal (bird) and the others are plant based (palm wine is tapped from the palm tree).

To administer the actual test, each farmer was presented with a triads test questionnaire consisting of triads combinations of 10 and 15 of the cassava varieties that were freelisted in Malende and Koudandeng, respectively, and asked to choose which variety was the most different and why. To avoid subjecting farmers to visible stimuli that clues them to base their judgement on the physical characteristics of the varieties placed before them, an oral test was administered so that the stimuli were abstract (Weller, 1983; Bernard, 1996, 2006). Data were collected at two levels: a vote for similarity and a vote for dissimilarity. The reasons for each vote was noted down and used for the construction of the attribute matrices. The similarity matrices of the varieties generated from the triads tests were subjected to cluster analysis and Property Fitting regression analysis with the varietal attribute matrices to help explain the results obtained from the cluster analysis. These analyses are discussed in detail in a following section on data analysis.

5.3.2.3 Follow-up interviews

Interviews were carried out with farmers to permit cleaning of the freelist data (e.g. eliminating redundant names for the same varieties), to understand the origin and meaning of varietal names, and to determine the factors that determine conservation of varieties in relation to why they grow them, have abandoned them or never have grown them.

5.3.3 Data Analysis Methods

Data obtained through interviews and literature review were mainly descriptive and explanatory or interpretive, and thus were analysed by making a narrative account of the findings and quotations. Freelist and triads test data processing and graphics were done using Microsoft Excel, while ANTHROPAC and SPSS were used for data analysis. ANTHROPAC was used for the analysis of data on farmers' varietal knowledge, to uncover their perceptions, as well as intra-cultural distribution and variation in cassava diversity knowledge and classification of the different cassava varieties that they grow. The analysis relates to the saliency of the different cassava varieties, aggregate proximities (similarities and dissimilarities) among the varieties and farmer sub-groups, the farmer socioeconomic attributes that determine the differences in salience and knowledge of the varieties across farmer sub-groups, and how farmers group order or classify their varieties and the dimensions along which the varieties are ordered and the reasons for such group ordering or classification. Farmers' cassava varietal evaluation and classification systems were further understood by means of an analysis of the attributes and use values of the different cassava varieties that they manage. SPSS was used to generate the following test statistics: t-test, Pearson's product moment correlation and R^2 across the different categories of farmers and varietal groupings. It was also used to analyse the relationship between the varietal clusters and the varieties that farmers actually grow. A description of the analysis that was done for each set of data is given below.

5.3.3.1 Analysis of freelist data

Farmers' individual freelist data were entered into the ANTHROPAC programme and used to analyse the level of salience of the different varieties across farmer sub-groups, individual farmer's agreement with the group in listing the varieties, the similarities among farmers in relation to their freelists, and the different farmer socioeconomic attributes (characteristics) that determine the variation in listing the varieties among farmers in the two villages.

a) Index of Saliency

The index of saliency proposed by Smith (1993) was used to analyse the freelist data because it takes into consideration the frequency and order of mention of the varieties. It is the weighted average of the inverse rank of an item across multiple freelists, where each list is weighted by the number of items in the list and is commonly known as Smith's Salience Index (Borgatti, 1996b). Using the Smith's Salience Index formula adopted by Borgatti (1996b), ANTHROPAC produced an output table showing: the frequency of mention of each variety for all the lists, a rank order list of the cassava varieties according to the variable saliency and the salience index of each variety.

b) Cultural Consensus Analysis

Cultural consensus analysis is a method that is used to assess the degree of interinformant agreement and thus the existence of agreement in cultural pattern among informants in a given set of data. According to the way it is commonly used, the agreement between respondents is the product of their respective competencies (Boster and Johnson, 1989). It was used in this research to estimate individual farmers' agreement with the group with respect to naming the varieties on their freelists.

To run the cultural consensus analysis using the formula adopted from Borgatti (1996a), ANTHROPAC dichotomised farmers' individual freelists to obtain a matrix that specified the order in which each variety freelisted appeared on each respondent's list. This output matrix was a farmer-by-variety matrix of dummy variables of "1" and "0" where a "1" against each corresponding variety indicates that that variety was listed by a given farmer and a "0" indicating that the variety was not listed by the farmer. This matrix of dummy variables was then subjected to consensus analysis where three main outputs were obtained: i) the reliability of the model in estimating the degree of agreement that each farmer has of the varieties freelisted with the group, which is depicted in figures 5.3 and 5.4 as pseudo-reliability; ii) the Eigenvalues, which are factor loadings of the farmers' individual competence scores on the fist factor; and iii) a matrix of individual cultural competence scores, which signifies the level of agreement of each individual with respect to the group. These scores were obtained by factoring the agreement matrix of corrected match coefficients between pairs of farmers. The match coefficients between pairs of farmers correspond to the similarities between each pair, which is calculated from the dichotomous data of farmers' freelists; and iv) the average score, which represents the percent of each farmers' agreement with the group in naming the varieties in each village.

c) Multidimensional Scaling (MDS)

Multidimensional Scaling (MDS) is a way of visually representing patterns of similarities or distances among objects. According to Borgatti (1996a), MDS is used to provide a visual representation of a complex set of relations that can be scanned at a glance. An MDS analysis of the agreement matrix that was produced by the cultural consensus analysis was used to compare the freelists of the informants and see if there was any significant variation among them based on age, sex, ethnicity, level of education, household HIV/AIDS status, household headship, family size, and number of varieties known and grown. To run the MDS scaling, ANTHROPAC scaled the farmer agreement matrix of match coefficients between pairs of farmers for each of the farmers' socioeconomic attributes listed above. The agreement matrix of match coefficients between pairs of farmers corresponds to the similarities between each pair, which is calculated from the dichotomised data of farmers' freelists. The output was a 2-dimensional space map, which shows the existing pattern of relationships among farmers for each village (see Appendix I). To obtain a more readable MDS map, the agreement matrix of match coefficients between pairs of farmers for each village was copied into the Excel program and subjected to MDS with the output being a scatter plot as is depicted in figures 5.2 and 5.3. The MDS map was interpreted by looking for clusters of farmers and the underlying dimensions that may explain perceived similarities between them.

d) Property Fitting (PROFIT) and Quadratic Assessment Procedure (QAP)

The Property Fitting (PROFIT) multiple regression technique was used to examine the underlying attributes that might explain the variation in farmers' freelists. The input datasets for the PROFIT regression analysis were the MDS map coordinates and the farmer attribute data. Farmers' demographic and socioeconomic attributes that were obtained during the household survey, the freelisting and triads testing exercises were entered into ANTHROPAC. The procedure for running the PROFIT regression analysis was as follows. In ANTHROPAC, social and demographic attributes were divided into metric (eg. age, family size, level of education, number of varieties grown) and non-metric (e.g. sex, household HIV/AIDS status; household headship, ethnicity) variables. The file of plot coordinates from the MDS analysis of the agreement matrix (produced in the consensus analysis) is essentially the dependent variable, and the file containing the metric attribute data is the independent variable; these files are the inputs in the PROFIT programme. PROFIT then regressed each of these metric attributes onto the coordinates of the MDS output (see Table

5.5). Non-metric attributes, or categorical variables, had to be analysed using the quadratic assessment procedure (QAP), which performs a regression of a 'dummy' matrix onto the informant agreement matrix (generated by the consensus analysis). The matrix of each categorical variable was converted into a 'dummy' matrix before running the regression analysis.

The output of the regression model was the R-square statistics, which tells us the amount of variation in the outcome variable that is accounted for by the model. In other words, the R^2-value gives the percent of variation in the data that can be explained by this variable and thus a high R-square signifies a closer relationship and *vice versa*.

5.3.3.2 Analysis of triads test data

The triads test data obtained for the two villages were entered into ANTHROPAC where data entry included the questionnaire number given to each respondent and the values that were obtained as the vote for similarities among items. These values were entered as 1, 2, and 3, which represent the 1^{st}, 2^{nd} or 3^{rd} variety in the triads that was chosen as the most different by the farmer. The choice of the most different variety was counted as the vote for the similarity among the two remaining varieties in the triads. Analysis was aimed at identifying proximities (similarities and dissimilarities) among the different cassava varieties through aggregate proximities analysis, the ways in which farmers group order or cluster their varieties and the attributes that seem to explain these clusters through cluster analysis.

a) Aggregate Proximities Analysis

In order to identify the existing sub-groups to which each variety pertains according to farmers' perceptions, and understand the underlying dimensions that farmers use to classify or group order the varieties so as to determine the most meaningful varietal attributes for farmers; aggregate proximities analysis was done. The input dataset to proximities analysis using the ANTHROPAC 4.0 programme was the triads test data for the two villages. ANTHROPAC carried out the analysis by transforming the respondent-by-variety matrix obtained for each village into a variety-by-variety matrix and then computing an aggregate correlation coefficient (proximity or similarity) matrix for further input for cluster analysis.

b) Cluster Analysis

To understand how farmers group order or cluster their varieties, the triads test data were subjected to cluster analysis through Johnson's (1967) Hierarchical Clustering using the complete linkage approach, also called the maximum or diameter method. The input data set into cluster analysis was the computed aggregate similarity (aggregate correlation coefficient) matrix of varieties. In this analysis, ANTHROPAC starts by grouping the varieties into fewer clusters and gradually merges them into larger clusters to form a cluster diagramme called a dendogram (tree diagram), thus showing the clusters that exist at each level of similarity. In this dendogram, to be seen in figures 5.4, 5.5 and 5.6, the names of the varieties were written vertically above the variety's code and the clusters presented at the different levels of clustering or iterations. The figures alongside each level of iteration represents the value of the maximum distance between varieties in the same clusters while the value of the last row or iteration is the maximum proximities between clusters or the value of the last item to be joined in one cluster and the last item to be joined in another cluster. In other words, the dendogram is presented such that the objects are the columns and the rows are the levels of clustering or iteration.

c) Property Fitting (PROFIT)

In order to understand and explain the way farmers group order their cassava varieties, scores of the varietal attributes as perceived by farmers that were obtained during triads testing were computed and subjected to Property Fitting (PROFIT) regression with the aggregate proximities (similarities) among the 15 and 10 varieties that were generated from the analysis of the triads test data in Koudandeng and Malende, respectively. The objective was to identify which dimensions or varietal attributes better explain the clusters observed in the cluster diagrams obtained through Johnson's Hierarchical clustering. PROFIT regression was done at village level and across the different farmer sub attributes (categories) that were identified to significantly determine the variation in naming the varieties on farmers' freelists. These included: age, family size, level of education, number of varieties grown, ethnicity, household HIV/AIDS status, and household headship. Even though sex of the farmer was not a significant determinant of the variation in listing the varieties, it was also used in the analysis to gain insights that could be useful for understanding the dynamics of gender relations in cassava diversity management. The results are presented in tables 5.16 and 5.17.

ANTHROPAC was used because it provides the possibility of coding categorical predictor variables with more than two categories into dummy variables before running the analysis. The categorical variables were in relation to farmers' socioeconomic attributes such as sex, level of education, household HIV/AIDS status, and ethnicity. The dummy variables were coded as "1" signifying that the attribute is present and "0" signifying absence of the attribute.

5.3.3.3 Analysis of freelist and triads test data in relation to the factors that determine cassava diversity

Factors influencing cassava varietal diversity among farmers were looked at in terms of how knowledge and classification of varieties relates to what farmers actually grow. Analysis was done at two levels: i) at the level of varietal salience and the percent of farmers growing each variety, and ii) at the level of the varietal clusters and what farmers grow in their fields.

The percent of farmers growing each variety was computed by tallying the scores of those who indicated that they were growing a variety in response to the follow up question to the freelisting exercise on whether they grew the variety or not during the year of the interview in each village. The scores for farmers growing each variety were then divided by the total number of farmers in each village, and then standardised by multiplying by one hundred.

Table 5.16 Varietal Attributes as Perceived by Malende Farmers

Class	*Attribute type*	*Attribute group*	*Pos. Neg. value*	*Kumba black stick*	*Agric short branc.*	*Red skin*	*Agric tall branch.*	*Kumba white stick*	*Red stick short branch*	*Yaounde*	*20 eye agric*	*Melong stick*	*Majeke*
Agro-ecology	Phenotype (morphology)	Shape and colour	1	10	7	4	9	8	0	4	10	0	3
	Crop management knowledge		1	4	4	6	5	3	0	1	1	0	1
	Pests and diseases	Tolerant to root rot	1	8	0	2	0	2	0	0	0	0	0
		Susceptible to root rot	-1	1	6	0	4	2	0	0	4	0	0
	Yield	High yield	1	41	45	19	11	24	0	9	16	0	2
		Average yield	1	1	2	2	4	2	0	1	0	0	1
		Low yield	-1	4	11	8	21	12	0	4	1	1	2
Food security	Maturation, harvest age and storage	Late maturing & store long underground	1	9	0	6	0	4	0	0	2	0	0
		Early maturing & doesn't store long	1	0	16	0	3	1	0	0	1	0	0
	Availibility of planting material and varietal substitutability	Availability means to buy; common	1	13	6	6	3	7	1	2	3	0	3
		Sccarcity; not readily available	-1	0	5	6	2	4	14	2	1	0	0
	Ensuring subsistence	Ensures subsistence	1	14	9	16	8	4	0	0	1	0	2
Food-ways	Processing qualities	Good	1	75	7	32	11	27	0	9	6	2	1
		Poor	-1	2	29	4	22	2	0	2	1	0	0
	Suitability for processed products		1	33	7	14	3	10	0	6	1	2	0
	Palatability	High	1	19	1	70	4	6	16	13	0	3	0
		Low	-1	1	4	4	3	1	0	1	0	0	0
Liveli-hood and culture	Income	Marketability & income source	1	33	20	18	11	12	0	0	1	0	2
		Income expenditure	1	5	2	2	0	4	0	0	0	0	0
	Exchange and labour saving		1	0	7	0	8	1	0	2	3	0	0
	Heritage		1	0	0	1	0	0	0	0	0	0	0

Table 5.16 Varietal Attributes as Perceived by Malende Farmers (con't.)

Class	*Attribute type*	*Attribute group*	*Pos. Neg. value*	*Yabassi*	*Black stem Susan*	*Black stick Mile 40*	*Yellow stem*	*Old stick*	*Ibo white stem*
Agro-ecology	Phenotype (morphology)	Shape and colour	1	0	0	0	0	0	8
	Crop management knowledge		1	0	0	1	0	0	0
	Pests and diseases	Tolerant to root rot disease	1	0	0	0	0	1	0
		Susceptible to root rot disease	-1	0	0	0	2	0	0
	Yield	High yield	1	0	0	0	12	0	13
		Average yield	1	0	0	1	0	0	3
		Low yield	-1	0	1	2	2	0	3
Food security	Maturation, harvest age and storage	Late maturing & store long underground	1	0	0	0	0	0	1
		Early maturing & does not store long	1	0	0	0	3	0	3
	Availability of planting material and varietal substitutability	Availability means to buy; common	1	0	0	0	1	0	2
		Scarcity; not readily available	-1	1	0	0	1	0	0
	Ensuring subsistence		1	0	2	2	0	0	0
Food-ways	Processing qualities	Good	1	0	0	1	3	1	8
		Poor	-1	0	0	0	4	0	3
	Suitability for processed products		1	0	0	0	0	1	7
	Palatability	High	1	0	0	0	6	0	7
		Low	-1	0	0	0	3	0	1
Livelihood and culture	Income	Marketability & income source	1	0	2	2	0	0	0
		Income expenditure	1	0	0	0	0	0	0
	Exchange and labour saving		1	0	0	0	1	0	4
	Heritage		1	0	0	0	0	1	0

In order to determine whether varietal salience is an important determinant of varietal diversity among farmers, the percent of farmers growing each variety was compared with the salience indexes of the different varieties for each village, by subjecting them to Pearson's correlation coefficient test statistics and regression analysis using the SPSS programme.

The outputs of the regression analysis were i) Pearson correlation coefficient r, which is the goodness-of-fit of the model in predicting the percent of farmers growing each variety; ii) the size of the relationship between the percent of farmers growing the varieties and the variety salience indexes (R^2), which is the proportion of variance in the outcome as explained by the model; iii) how much the model has improved the prediction of the percent of farmers growing each variety as compared to the model's level of inaccuracy (F-ratio) using the F-test statistic; and iv) the significance of the contribution of each predictor variable in predicting the outcome using the t-test statistic. This analysis is called assessing individual predictors.

The relationship between the way that farmers cluster their varieties and what they grow was analysed by recoding the varieties that farmers grew in 2007 into the clusters that they pertain to according to farmers' classification. The purpose was to understand how farmers relate their perceptions of the different varieties to their decision-making frameworks in cassava production, which may influence diversity loss or maintenance. Arbitrary numbers were attributed to the clusters formed during cluster analysis, and the varieties that farmers indicated that they grew in 2007 were assigned the numbers of the clusters according to the cluster to which they belong. To obtain the frequency of the varietal clusters in farmers' fields, the number of times that any variety belonging to a particular cluster was mentioned as grown was counted as a score for that cluster's occurrence in a farmer's field. The total number of times that varieties pertaining to a cluster were mentioned was calculated to represent the frequency of occurrence of that cluster in a farmer's field, and these were then divided by the total number of occurrence of varieties in a farmers' field to obtain the proportion of occurrence of a cluster in a field. The percent occurrence was obtained by multiplying the proportion of occurrence by 100. The results are presented in Table 5.22.

5.3.4 Limitations

The limitations encountered were with respect to the application of the freelisting technique for data collection and the cultural consensus model in estimating knowledge and in carrying out the PROFIT regression analysis. A detailed explanation is given below.

With regard to the freelisting exercise, farmers in the two villages may have different names for the same varieties, and it was not possible to match the names of the varieties listed in the two villages under study since the varieties themselves were not collected and identified, which was beyond the scope of this research since accurately identifying closely related landraces is costly and requires the use of sophisticated methods such as Isozyme patterns or DNA markers (see e.g. Colombo et al., 1998). Therefore, the data for these two villages was analyzed separately. This limits the ability to compare the villages and to compare across all farmers in the sample, but it does not limit the ability to compare within villages among farmer groups. Identification of the varieties to facilitate comparison between the villages is beyond the scope of this research. Further, in Koudandeng, there were only two male cassava farmers, which means that comparison between men and women was not possible. Interviewing everyone in the village and not just cassava farmers would have permitted a better analysis by sex as well as captured more general knowledge versus specialist producer knowledge, but the objective of this research was not to test knowledge of the population more generally. Also, as explained earlier, Koudandeng men did not find it culturally appropriate to talk of crops that are typically managed by women.

Using cultural consensus as a means of analysing farmers' knowledge of the cassava varieties was problematic because the consensus model requires that freelist data be subjected to multiple choice test question before carrying out the analysis to estimate the culturally correct answers and the cultural knowledge. This limited the analysis to measuring cultural agreement. In other words, the cultural consensus model measured the level of an individual farmers' agreement with the group in listing the varieties and not knowledge and so it was difficult to estimate the culturally correct cassava varieties since no correction for guessing was possible.

With respect to the PROFIT regression analysis, the input dataset into PROFIT regression using ANTHROPAC is the MDS map coordinates, which are used as the independent variable. This implies that the procedure for determining the famer attributes that influence the variation in naming the varieties on farmers' freelists using PROFIT regression analysis must use the outputs of consensus analysis and multidimensional scaling (MDS) and not raw data.

5.4 Results

5.4.1 Characteristics of the Study Population

As indicated above, the 114 farmers who participated in the freelisting and triads testing exercises in the two villages were selected from the list of those who participated in the household and cassava surveys as well as those who did not participate in the survey but were willing to participate in the knowledge test exercises but grow cassava as well. Table 5.1 depicts the non-metric socioeconomic attributes (characteristics) of these farmers while the metric attributes are presented in Table 5.2.

Twenty percent of the farmers studied are men. In relative terms, Malende men (38.2% of all Malende cassava farmers) are more involved in cassava production compared to Koudandeng men (3.4% of Koudandeng cassava farmers). With respect to ethnic diversity, the sample in Malende contained 10 different ethnic groups compared to Koudandeng, whose farmers are mainly from the Etone tribe (Lekie Division). While all 59 farmers in Koudandeng hail from the Centre province, Malende farmers hail from four administrative provinces. In relation to household headship, 11.9% and 16.4% of the households studied in Koudandeng and Malende, are female headed, respectively.

In relation to the HIV/AIDS status of a household, four categories of households were identified: non-affected households (50.9% of the households studied), affected households (12.1%), afflicted households (21%) and likely afflicted households (16%). Non-afflicted households are those that have no HIV/AIDS orphans, nor have they lost a relation who suffered from HIV/AIDS within the last five years, nor do they have an HIV/AIDS patient as a member. Affected households are those that have at least one HIV/AIDS orphan, but have no AIDS afflicted person living in their home currently or in the past. Afflicted households are those that either have HIV/AIDS patients or have lost a household member within the last five years who suffered from HIV/AIDS. Likely afflicted households are those that have members suffering from HIV/AIDS proxy illnesses as defined by the World Health Organization and the Cameroon National Committee for HIV/AIDS Control. Contrary to most studies on HIV/AIDS that have often placed persons suffering from HIV/AIDS proxy illnesses as being afflicted or victims, the standpoint of this research is that not all persons suffering from HIV/AIDS proxy illnesses may be HIV positive. Malende seems to be more highly affected by the HIV/AIDS pandemic compared to Koudandeng (Table 5.1).

Table 5.1 Farmer Non-metric Socioeconomic Attributes (Characteristics)

Demographic and Socioeconomic Charcteristics	Koudandeng		Malende	
	Number	%	Number	%
Sex:				
Men	2	3.4	21	38.2
Women	57	96.7	34	61.8
Household HIV/AIDS status:				
Non-afflicted	37	67.2	21	38.2
Affected	3	5.1	11	20
Afflicted	12	20.3	12	21.8
Likely afflicted	7	11.9	11	20
Household headship:				
Female	7	13.5	9	16.4
Male	52	86.5	46	83.6
Ethnicity:				
Native	57	96.6	8	14.5
Ewondo	1	1.7	-	-
Sanaga	1	1.7	-	-
Bakossi	-	-	2	3.6
Menemo/Moghamo (Momo Div.)	-	-	18	32.7
Bayangi	-	-	1	1.8
Balondo (Ndian Division)	-	-	1	1.8
Albo – Douala	-	-	3	5.5
Bangnwa	-	-	11	20
Tikari (Bafut/Ndop)	-	-	3	5.5
Aghem/Beba/Modele (Menchum)	-	-	5	9.1
Bameleke	-	-	3	5.5

In order to further understand the dynamism of the variation in naming cassava varieties from farmers' freelists and the classification of these varieties among farmers, the farmer metric socioeconomic attributes that significantly determine this variation were further divided into three sub-groups and analysed. To obtain the sub-groups, the values of each metric attribute were plotted on a frequency distribution curve where the median, the first, second, third and fourth quartiles of the curve were determined. The farmers that fell within the range of the 1^{st} quartile were considered as one group, those that fell within the limits of the fourth quartile were considered as another group and the farmers who fell within the second and third quartiles were considered as yet another group. For example, in relation to age, young farmers are those who fall within the range of the first quartile, while middle age farmers are those who fall within the limits of the second and the third quartiles and the elderly farmers fall within the limits of the upper quartile.

Table 5.2 shows that Koudandeng and Malende are significantly different in relation to their mean ages, family sizes, level of education, and number of cassava varieties grown and listed. On average, Koudandeng farmers are much older, have larger families, know and grow more cassava varieties as compared to Malende farmers who seem to have attended higher levels of education than Koudandeng farmers.

Table 5.2 T-test of Differences in Means of Selected Farmers' Metric Socio-economic Attributes Between the Two Research Villages

Demographic and Socioeconomic Attributes	Koudandeng			Malende			T-test (2-tailed)
	Range	Mean	Standard deviation	Range	Mean	Standard deviation	
Age (years)	23 to 75	48.73	13.06	26 to 70	43.89	7.92	.015*
Family Size	4 to 17	8.36	3.23	2 to 18	7.06	2.53	.008**
Number of years of education	0 to 14	5.89	3.41	0 to 17	8.82	4.22	.000***
Number of varieties grown	3 to 14	6.57	2.47	1 to 6	2.96	1.276	.000***
Number of varieties listed	6 to 17	11.03	2.971	2 to 9	4.27	1.52	.000***

* = p < .05; ** = p < .01; *** = p<.001

In relation to the sub-groups, 27.2% of the total population studied is young (< 42 years), 46.5% is of middle age (43 to 58 years) and 26.3% is elderly. 30.7% of the households are small (< 5 members), 53.5 % are medium size (6 to 10 members), and 15.8% are large (> 10 members). Some 14% of the farmers are illiterate, 54.4% have a basic level of education (have some primary school education or completed primary school) and 31.6% attended post-primary institutions (attended secondary school, learned some type of profession after primary school, or attended post secondary education).

The proportion of farmers who have attended post primary institutions is higher for Malende (61.1%) than for Koudandeng (39.9%), while the proportion of illiterate farmers is higher for Koudandeng (68.8%) than for Malende (31.2%).

With respect to the number of cassava varieties freelisted in each village, farmers who fell within the 1st quartile of the frequency curve listed few varieties, while those who fell within the 2nd and the 3rd quartiles grew an average number and those who fell within the 4th quartile grew many varieties. In total, 36% of all the farmers listed few varieties, 36.8% listed an average number of varieties and 27.2% listed many varieties. A classification of the number of varieties grown in 2007 also followed a similar procedure where 36% of farmers grew few (≤5 for Koudandeng, ≤2 for Malende), 42.1% grew an average number (6-8 for Koudandeng, 3-4 for Malende) and 21.9% grew many varieties (9-14 for Koudandeng, 4-6 for varieties were listed in Koudandeng and 16 varieties were listed in Malende. Twenty-six out of the 28 cassava varieties listed are grown in Koudandeng, while Malende farmers grow all of the 16 varieties that they listed. An average Malende farmer knows five cassava varieties but grows three varieties while an average Koudandeng farmer knows 11 varieties but grows seven. In general, Koudandeng farmers who are more subsistence oriented know and grow more varieties compared to Malende farmers who are more commercially oriented and more ethnically diverse.

5.4.2 Vernacular Varietal Names

Language is the cultural means by which peoples' perceptions are organised, meaning given to things and phenomena in the environment. Language is also the primary means of sharing ideas and events, past and present. Thus, language is the medium through which culture is experienced and shared through communication. Culture can be heard by listening to language in a certain way, and thus language is linked to culture (Silverstein, 2004). Koudandeng and Malende cassava farmers use a particular convention when naming varieties; where the different names refer either to the variety's introduction into the village, phenotypic characteristics, use value, culinary quality, or food security quality. The names of some varieties combine two or more of these characteristics. However, not all of the varieties named in Koudandeng conform to these naming conventions.

In relation to the variety's introduction into the village of study, names often refer to the source of a variety, which may include the name of the first person to introduce it, the name of the ethnic group that introduced it, the place of origin or, in the case of HYVs, the name of the institution that introduced it. Cassava varieties introduced by local research and extension institutions (Irad, IITA, ICRAF, NAERP or PNVRA, NGOs) are called "Irad" in Koudandeng, and "Agric" in Malende. In Malende, the term 'agric' is followed by a suffix denoting the phenotypic characteristics of the variety, and the latter is used to differentiate between Irad or Agric varieties. For example, one finds terms such as 'Agric short branching', implying that the agric variety has branches that emerge low on the stem and thus the plant is relatively short; 'Agric tall branching' means that the agric variety has a tall stem that branches off higher up. Examples of varietal names in relation to the place of origin include: Black stick Mile 40 (found in Mile forty along the Buea – Kumba road), Mbokani (a village neighbouring Koudandeng), and Mekoughe congo (brought by a villager who resided in the Democratic Republic of Congo). In relation to the first person who introduced the variety into the village, one finds terms such as Ndongo esombe and Bela mpeughe in Koudandeng, which are the proper names of people. Ibo white stick is a variety that exists in Malende that was purportedly introduced by a small ethnic group called the Ibo who migrated from Nigeria. Moung eligedja nanga is a variety that is grown by the migrant settlers of Eligedja in Yaounde who come from Nanga Eboko in the East of Cameroon.

Naming of cassava varieties by phenotypic characteristics is in relation to the structure, size, and colour of the visible plant parts. Examples of such names are yellow stick, tall branching, Muane moung ('child' cassava, with small tuber sizes and thus likened to a child) and Manioc jaune (Yellow cassava). Research institutions introduced Yellow stick or Yellow cassava (Manioc jaune) between 1982 and 1986. The following phenotypical names were encountered: yellow stick, black stick, white stick, short branching, tall branching, Red stick, and Red skin and potato cassava, whose skin colour is as yellow as the skin colour of sweet potato in Malende; Manioc jaune (Yellow cassava), Ntangne thick skin and Ntangne thin skin (referring to the thickness of the cassava tuber peel), Ikwemi (white: as white as the zinc of Nkometou); and Muane moung (child cassava: tuber sizes as small as a child) in Koudandeng.

Varietal names that are related to culinary qualities are related to taste, such as mekoughe and mevina, which means bitter; meboura, which means sweet potato because the variety tastes like sweet potato; Six mois doux (six months sweet) and Six mois amère (six month bitter). Bitter and sweet taste correlates with the level of toxicity of the variety concerned.

With respect to food security characteristics, maturation stage and ability to stave off hunger are used in naming some varieties. In Koudandeng, these include the varieties called Six mois (meaning 'six months', which mature six months after planting), Zayabo ayi madje, meaning "what will hunger do to me" because it is early maturing, and Adjudi bikwane (meaning sweeter than ripe plantain (which is mainly grown for family consumption).

In relation to a social function, two varieties were identified whose names are related to their high market value. In Koudandeng, "fonctionnaire" means civil servant. Civil servants are government employees who are considered to be rich because they earn a steady high income. Fonctionnaire varieties are high yielding, early maturing, have high market value (with large long or round roots, a sweet taste, and good aroma), a smooth tuber peel, which is attractive to customers, and are therefore easily and rapidly sold. This allows farmers to earn higher income and to become as rich as government civil servants. These varieties are most widely known and grown in Koudandeng, as discussed in sections 5.4 and 5.5.

Table 5.3 summarises how the convention is applied to the names of specific varieties and their meaning in Malende and Koudandeng. Analysis of this table shows that, in Malende, where cassava is grown more to complement household subsistence (food and income) and where the influence of research and extension institutions has been greater, farmers employ mainly the naming conventions relating to phenotypic characteristics (colour, structure) and source of introduction into the village (name of research institute, place of origin). Using colour and structure of plant parts when naming varieties is linked to the scientific characterisation of varieties according to phenotypical features, as can be seen in the 2007 IITA technical guide (IITA, 2007). In contrast, in Koudandeng, where cassava is the main staple, farmers employ all of the different naming conventions indicated in the table. Especially, naming conventions that are related to introduction (place of origin, the first person to introduce the variety) and culinary and food security qualities are important.

Koudandeng cassava farmers are mainly women, who are responsible for ensuring family food security, which may explain why they name varieties in relation to maturation age and ability to stave off hunger. However, in both villages, the name of the introducer institution is used to differentiate between local and research and extension introduced varieties, a convention that may tend to help to conserve the former varieties since these have clearly distinguishable naming conventions.

5.4.3 Cassava Varietal Knowledge, Salience, and Knowledge Distribution between Villages

This section discusses farmers' knowledge of cassava varieties by looking at the index of salience of these varieties, the knowledge competences of individual farmers in naming (freelisting) the different varieties, and the intra-cultural distribution of this knowledge by sex, age, number of varieties grown, household headship, level of education, ethnicity, HIV/AIDS status, and family size of the farmers interviewed. It should be noted that some socio-economic and cultural characteristics might provide significant explanations for the variation in the listing of varieties, whereas others may be important but are not significant determinants of such variation between Malende and Koudandeng.

In all, 28 varieties were listed in Koudandeng and the ten most salient varieties are all landraces, as can be depicted in Table 5.4. An average Koudandeng farmer listed 11 varieties. In Malende, where cassava is grown to supplement food and income, 16 varieties were listed by the farmers interviewed and on average four varieties were listed per farmer. For Malende, the five most salient varieties are a combination of those introduced by research institutions (2) and local (3) varieties.

Of the thirteen cassava HYVs that were released by research institutions (Irad, ICRAF) between 1986 and 2002 (IITA, 2002), only two are known in Koudandeng: the variety called Irad and Manioc jaune (Yellow cassava). These occupy the 18th and 19th positions of salience among the 28 varieties named in this village and have very low salience (Smith's S: Irad = 0.041, Manioc jaune = 0.035). Of the 59 farmers interviewed, 12 mentioned Irad while eight mentioned Manioc jaune. In Malende, in contrast, four of the HYVs were listed: the varieties called Agric short branching, Agric tall branching, 20 eye agric and yellow stick. These occupy the 2nd, 4th, 8th and 14th positions of salience, respectively, among the 16 varieties that were listed (Table 5.4). Given Koudandeng farmers' descriptions of the variety called Irad, it is likely to be the same variety that is called Agric short branching in Malende. Manioc jaune (Yellow cassava) is called Yellow stick in Koundandeng and Potato cassava in Malende.

It is clear from tables 5.4 and 5.5 that the HYVs are not among the most salient but rather feature among the ten least salient in the more subsistence oriented Koudandeng, whereas two out of the four HYVs in the more commercial oriented Malende feature among the six most salient varieties in this village. The respective low Smith's Salience indexes of the HYVs indicate their low significance or meaningfulness to farmers in Koudandeng. On the other hand, Agric short branching is highly significant to Malende farmers (salience index of 0.628) (Table 5.5).

A variety may rank higher on the freelist but, because not many people mention it, it will have a lower salience index as is the case of Atanghai and Mbembong in Koudandeng. This is because ANTHROPAC takes account of both the frequency and position of mention of each variety across informants when calculating the salience index. Koudandeng farmers had longer lists of varieties compared to Malende farmers. One would have expected that because Malende is more ethnically diverse a larger total number of varieties would have been listed, since the farmers bring along the varieties that are grown in their villages of origin, but this is not the case.

When examining salience, this can be broken down into the most salient, which are the core varieties, those that are listed by many people at a time and idiosyncratic varieties. The core varieties are listed by more than 10 farmers and therefore reflect the existence of a shared cultural concept of a domain, whereas additional items represent idiosyncratic views of individuals. Based on the freelist analysis, one can conclude that 17 core varieties exist in Koudandeng and six core varieties exist in Malende, and Koudandeng has five idiosyncratic varieties and Malende has four. However, some varieties in both villages were mentioned by more than one person but also have a very low Smiths' S value, and thus are neither core nor idiosyncratic varieties. While the variation in the frequencies of the different varieties listed may be due to individual differences, it also reflects the degree of diversity of varieties that are mentioned in the two villages.

Table 5.3 The Logic of Naming Certain Cassava Varieties in Koudandeng and Malende

Naming Logic	*Koudandeng*		*Malende*	
	Varietal Name	*Meaning of Name*	*Varietal Name*	*Meaning of Name*
1. Social function	Fonctionnaire feuilles verte Fonctionnaire feuilles rouge	Just like a civil servant, who is rich		
	Menyo mbandjock	From Mbandjock, Centre Province	Yaounde	Introduced by Yaounde migrants
	Mekoughe congo	From the Democratic Republic of Congo	Kumba black stick, Kumba white stick	From Kumba, a neighbouring town
	Sanegai	From Senegal	Melong stick	From Melong, West Province
	Obala, also called Isanga	From Obala	Yabassi	From Yabassi, Littoral Province
	Ikwemi bi nkometou	From Nkometou, a neighbouring village and one of the main cassava markets		
b) Name of introducing institution	Irad	From the World Agroforestry Centre (ICRAF) and the Institute of Agricultural Research for Development (IRAD), both in Yaounde.	Agric short branching, Agric tall branching, 20 eye agric	Introduced by IRAD at Ekona and extension workers of the sub-delegation of Agriculture and Rural Development at Muyuka
c) Name of 1st Introducer	Bela mpeughe, also called Ntangne	Introduced by a lady from the village of Bela Mpeughe	Black stem Susan	Introduced by a rural community development worker called Susan
	Ndongo esombe (also called Menyo mbandjock	Introduced by a man in the village called Ndongo Esombe who temporarily migrated to Mbandjock		
3. Morphology a) Structure of plant parts	Ntangne peau épais	Ntangne with thick tuber peel	Agric tall branching	Stem branches off higher
	Ntangne peau légère	Ntangne with thin tuber peel	Agric short branching	Stem branches off lower
			20 eye agric	Stem has many shoots

Table 5.3 The Logic of Naming Certain Cassava Varieties in Koudandeng and Malende (con't.)

Naming Logic	*Koudandeng*		*Malende*	
	Varietal Name	*Meaning of Name*	*Varietal Name*	*Meaning of Name*
	Manioc jaune	Yellow tubers	Ibo white stem Kumba white stick	Varieties with white stem
	Fonctionnaire feuilles verte	Green leaves civil servant	Kumba black stick, Black stick Mile 40, Black stem Susan	Varieties with black stem
	Fonctionnaire feuilles rouge	Red leaves civil servant	Yellow stick	Variety with yellow stem colour
			Potato cassava	Tuber as yellow as sweet potato
c) Tuber size	Muane moung	Child cassava. Small tuber size		
4. Culinary Qualities a) Tuber taste (toxicity)	Mekoughe congo Mevina (Six mois) amère	Bitter varieties, toxic when unprocessed, with high cyanide content		
	Mevina (Six mois) doux	Sweet variety, low cyanide content		
	Meboura	Tuber as sweet and dry as sweet potato		
5. a) Maturation age	Six mois amère Six mois doux	Mature at six months after planting		
b) Staves off hunger	Adjudi bikwane, also called Menyo mbandjock	Sweeter than ripe plantain, thus more often eaten than ripe plantain		
	Zayabo ayi madje	What can hunger do to me? The variety matures early and is high yielding		

Source: Follow up questions to freelisting; interviews

Table 5.4 Saliency Indexes of Cassava Varieties Listed in Koudandeng

Rank	*Variety*	*Frequency*	*Respective %*	*Average rank*	*Smith's S*
1	Fonctionnaire feuilles verte	55	93	3.818	0.685
2	Fonctionnaire feuilles rouge	56	95	4.036	0.681
3	Mbokani	57	97	4.754	0.637
4	Mintole minko	52	88	5.154	0.549
5	Muane moung	44	75	4.25	0.526
6	Ikwemi	50	85	5.64	0.498
7	Menyo mbandjock (Adjudi bikwane or	47	80	6.255	0.455
8	Six mois (or mevina) amère	52	86	7.216	0.386
9	Ntangne (or Bela mpeughe) peau épais	32	54	7.313	0.272
10	Ntangne (Bela mpeughe) peau légère	31	53	7.71	0.247
11	Six mois (mevina) doux	32	54	8.063	0.231
12	Menyo local	31	53	8.774	0.211
13	Sanegai (or Obala)	25	42	8.8	0.155
14	Mekoughe	17	29	8.706	0.104
15	Mekoughe congo amère	12	20	8	0.092
16	Moung eligedja nanga	5	8	6.6	0.047
17	Meboura	14	24	11.429	0.047
18	Irad	12	20	11.583	0.041
19	Manioc jaune	8	14	11.375	0.035
20	Zayabo ayi madje	4	7	8	0.018
21	Zama	1	2	11	0.017
22	Isanga	3	5	9.667	0.015
23	Apoba moung	3	5	11.333	0.014
24	Atanghai	1	2	5	0.011
25	Nkodouma (Douma moung)	3	5	14.333	0.009
26	Mbembong	1	2	7	0.008
27	Irad Local	1	2	8	0.007
28	Shicago	1	2	14	0.002
	Total/Average varieties listed	650	11.017		

This diversity in varieties named may be due to intra-cultural variability and to differences in knowledge (cultural literacy) regarding the varieties known, which results in different varieties being listed by different individuals. Cultural consensus analysis was therefore done to analyse farmers' freelists to examine the level of cultural agreement on varieties named by different categories of farmers in the light of the existence of intra-cultural variability in varietal listing. Eigenvalues were computed in order to test whether these assumptions hold or not. The results of the consensus analysis are represented in Figure 5.1.

Table 5.5 Saliency Indexes of Cassava Varieties Listed in Malende

Rank	*Variety*	*Frequency*	*Respective %*	*Average rank*	*Smith's S*
1	Kumba black stick	55	100	1.727	0.835
2	Agric short branching	48	87	2.125	0.628
3	Red skin	43	78	3.186	0.378
4	Agric tall branching	26	47	3.308	0.271
5	Kumba white stick	19	35	3.211	0.206
6	Red stick short branching	16	29	3.188	0.136
7	Yaounde	6	11	4.000	0.056
8	20 eye agric	3	5	4.667	0.026
9	Majeke	2	4	5.000	0.017
10	Melong stick	3	5	5.667	0.017
11	Black stem Susan	3	5	6.333	0.012
12	Black stick Mile 40	4	7	6.500	0.012
13	Yabassi	1	2	6.000	0.007
14	Ibo white stick	1	2	8.000	0.004
15	Yellow stick	1	2	6.000	0.003
16	Old stick	1	2	8.000	0.002
	Total/Average varieties listed	232	4.218		

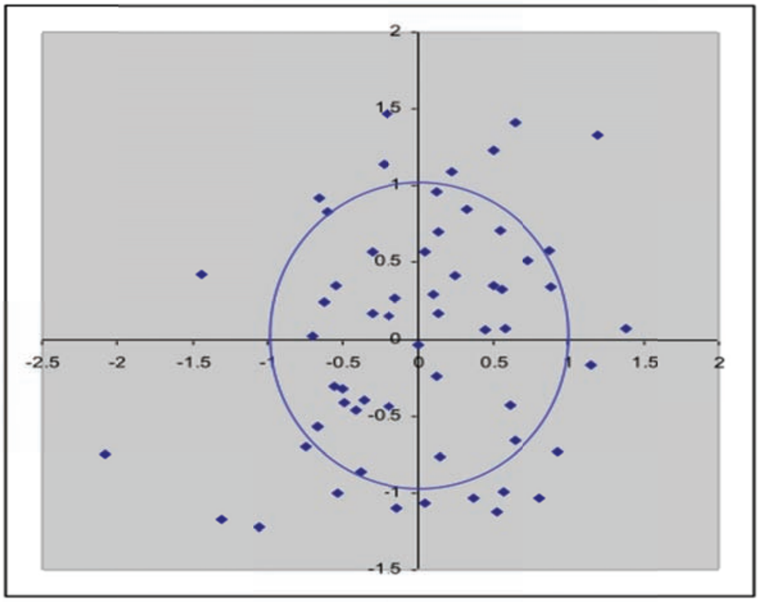
Figure 5.1 Cultural Consensus Model of Cassava Varieties Freelisted

Koudandeng varieties: pseudo-reliability = 0.985				
Factor	*Value*	*%*	*Cum %*	*Ratio*
1:	31.691	78.6	78.6	5.970
2:	5.309	13.2	91.8	1.610
3:	3.298	8.2	100.0	
40.297	100.0			
Malende varieties: pseudo-reliability = 0.990				
1:	37.097	80.6	8.167	8.167
2:	4.542	9.9	90.5	1.038
3:	4.376	9.5	100.0	
46.016	100.0			

The cultural consensus model used is highly reliable (pseudo-reliability 0.985 for Koudandeng and 0.990 for Malende) for explaining the variation in cassava varietal naming among farmers in both villages. The ratio of the first eigenvalue to the second is greater than three to one for both villages (5.970 for Koudandeng, 8.167 for Malende), thus confirming that there is one culture in each village with respect to listing the varieties and the variation among farmers' responses do not represent sub-cultures in the villages.

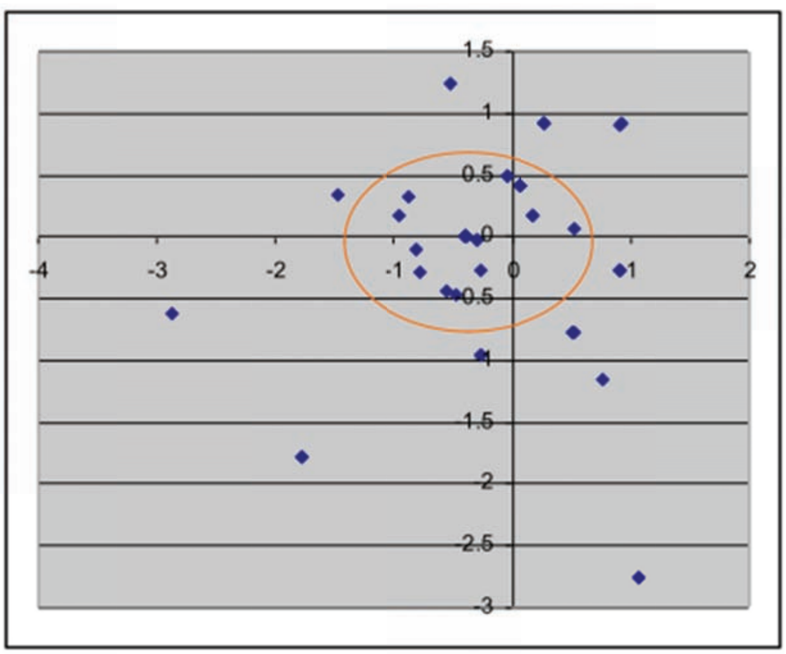
To compare the freelists of the informants and see if there is any significant variation among them, we can use an MDS analysis of the similarity matrix that is generated by the Cultural Consensus analysis. The plots below (figures 5.2 and 5.3) show the similarity (or distance) between informants in two dimensions for Malende and Koudandeng.

Figure 5.2 Multidimensional Scaling of Koudandeng Farmers' Similarity in Naming the Varieties*



*Each dot on the map represents a farmer where the input to the MDS is the similarity matrix generated by the Cultural Consensus Analysis.

Figure 5.3 Multidimensional Scaling of Malende Farmers' Similarity in Naming the Varieties



*Each dot on the map represents a farmer where the input to the MDS is the similarity matrix generated by the Cultural Consensus Analysis.

The high concentration of farmers around the centre of the graphs in figures 5.2 and 5.3 further confirms that there is high agreement among farmers in the varieties named on their freelists. Malende farmers exhibit greater agreement (thus similarity) (concentration of points between 0.5 and -0.5 on Figure 5.3) in listing their varieties compared to Koudandeng farmers (concentration of points between 1 and -1 on Figure 5.2). The dimensions along which farmers are similar in listing the varieties may be more for Koudandeng than for Malende.

5.4.4 Intra-cultural Cassava Varietal Names and Naming Distribution across Farmer Sub-groups

Considering farmers as a single, undifferentiated group obscures the existing intra-cultural variation among them (Howard, 2003), which directly influences their knowledge in cassava diversity management. Likewise, the category 'cassava farmer' disguises much variation in farmers' livelihood options so that cassava knowledge and preferences are varied. Farmers have different social identities: they are of different sexes, ages, some are migrants and some are natives, they have different production orientations (objectives) and different levels of education, different household headship status, and family sizes.

The advent of HIV/AIDS has also changed the status of some farmers and their households. These factors mean that they do not all know and manage the same cassava varieties and number of varieties. Faced with this diversity, there is much potential variation in the listing of and preferences for different cassava varieties. For example, labour shortages in female headed and HIV/AIDS afflicted households could lead to greater preference for (and salience of) less labour intensive varieties. It is therefore necessary to understand this variation in greater detail if a contribution to the bigger picture of cassava diversity in scientific debates and development interventions is to be made from the findings of this research.

The fact that farmers listed different varieties and listed different numbers of varieties may be attributed to underlying factors of their social identity or socioeconomic attributes. As indicated earlier, there seem to be groupings along different farmer demographic and socioeconomic lines in which variation in listing the varieties among farmers exist, which implies that various patterns of agreement (similarity) and dissimilarity (disagreement) exist among them. Uncovering the factors that seem to order farmers' responses and therefore determine diversity can be achieved by plotting farmer demographic and socioeconomic attributes along a continuum to determine where these differ or are similar to each other and identifying clusters (sub-domains or categories) that seem to explain the existing variation. While emphasising the fact that similarity judgements are based on the idea that farmers have different attributes (socio-economic characteristics) in varying degrees and the similarity between farmers is a function of their similarity in scores across all their attributes, it is also necessary to point out that farmers may have different understandings of the varieties named from that of the researcher. Further, the observed patterns on the MDS maps (figures 5.2 and 5.3) may be more a result of the researcher's attention than it is in reality, which requires an objective assessment of the degree to which the farmers are similar.

The Property Fitting (PROFIT) and Quadratic Assessment Procedure (QAP) regression techniques were used to test the hypothesis about the underlying attributes that influence the variation observed from the freelists in relation to the social attributes of the farmers studied. In other words, the technique was used to understand the criteria that determine the similarities or agreement in listing the varieties across informants. Table 5.6 depicts the results of this regression analysis for both metric and non-metric attributes.

Table 5.6 Farmer Socioeconomic Attributes by Freelist PROFIT and QAP Regression Results

Variable	*Koudandeng*			*Malende*		
	Multiple R	R^2	*Probability*	*Multiple R*	R^2	*Probability*
Sex	0.189	0.036	0.374	0.112	0.012	0.752
Age	0.343	0.118	0.025*	0.011	0.000	0.999
Number of varieties grown	0.428	0.183	0.007**	0.575	0.331	0.001***
Household headship	0.351	0.123	0.033*	0.044	0.002	0.948
Level of education	0.353	0.125	0.026*	0.254	0.065	0.151
Ethnicity	0.102	0.010	0.730	0.404	0.202	0.000***
Household HIV/AIDS status	0.324	0.105	0.022*	0.190	0.036	0.382
Family size	0.282	0.080	0.094*	0.030	0.001	0.980

i) *** = $p \leq .001$; ii) ** = $p \leq .01$; iii) * = $p \leq .05$, $p < .1$

The R^2 value gives the percent of variation in the data that can be explained by this variable, thus high values imply the closer the relationship between the varieties named and a given socioeconomic attribute of those who named it. The probability value signifies the probability that the value of R does not occur by chance and thus the socioeconomic attribute related to this value determines the similarity among farmers with respect to listing a given variety on their freelists. A probability value <.05 is significant (P<.1 is weakly significant), which implies that the corresponding socioeconomic attribute significantly determines the clustering of farmers in relation to the varieties listed as endorsed in the MDS output coordinates.

Results of this analysis show that, in Koudandeng where cassava is the main staple crop, the number of varieties grown, the age of the farmer, household headship, family size, and HIV/AIDS household status are significant determinants of the diversity in naming of varieties on farmers' freelists. Family size, even though significant, is a weak determinant of this variation. On the contrary, the sex and the ethnicity of the farmer do not significantly determine the variation in listing the varieties (Table 5.6). Out of the three tribes that were represented among the farmers studied, one is from the Ewondo tribe, one from the Sanaga region (Mbam et Innoubou administrative Division) and 57 (96.6%) are of the Eton tribe and mostly come from the Obala administrative subdivision. Women mainly grow cassava, and only two male farmers in the village grow cassava, and both were interviewed. In Malende, where cassava is mainly grown to supplement family income and diet, only the number of varieties grown and ethnicity are significant explanations for the diversity in the cassava varieties listed (Figure 5.3). Irrespective of sex, age, level of education, family size and household headship and HIV/AIDS household status, farmers know almost the same type of varieties. These PROFIT multiple regression and QAP regression results explain the clustering that is observed in the MDS plots of figures 5.2 and 5.3 above.

5.4.5 Farmers' Cassava Varietal Evaluation Systems

It is also important to examine why such distribution patterns exist in varietal naming and salience, and why some cassava varieties are highly salient and others are not. The following questions are addressed: i) how do farmers perceive the different cassava varieties that they know? In other words, how do different categories of farmers perceive similarities and dissimilarities between varieties, and how do they classify them? ii) Which varietal attributes (characteristics) are the most salient to farmers and how does this differ according to the orientation of their production systems? iii) How do farmers perceive local varieties versus HYVs? For this purpose, triads test data were analyzed to discover the dimensions (attributes) that farmers use in structuring or ordering these cassava varieties. This entails analysis of the proximities (similarities and dissimilarities) between varieties and mapping of their structure, that is, identifying existing sub-groups or clusters into which each cassava variety falls, in order to examine the varietal attributes that tend to form clusters, so that, if a cassava variety has one of the attributes, then it is also most likely to have other attributes in the cluster.

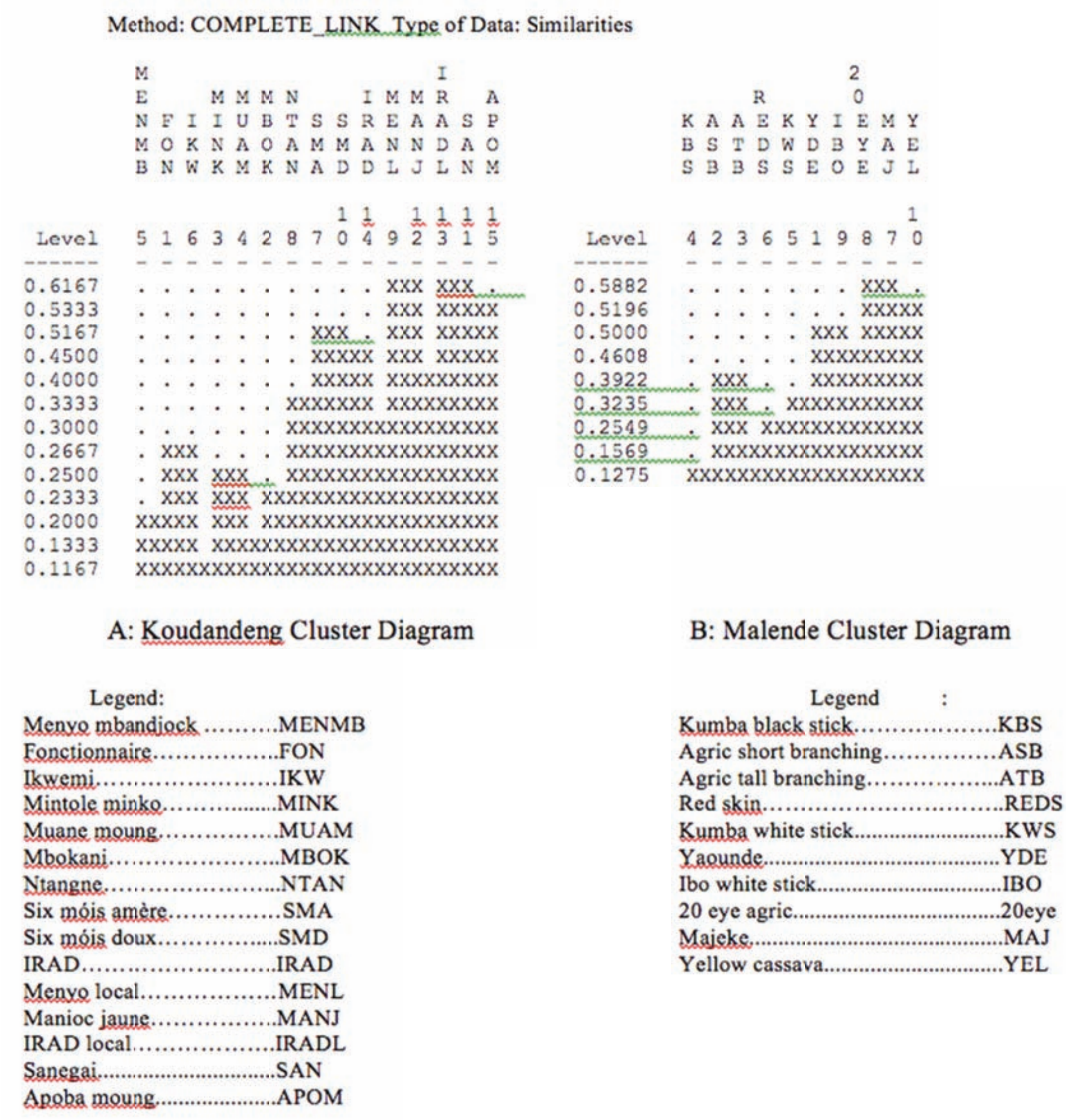
As indicated in the section on methodology, 10 and 15 cassava varieties were used for the triads testing in Malende and Koudandeng, respectively. The selection criteria was such that the most and least salient, and local and reseach-introduced varieties were included, while considering the diversity of the varieties as well as the number and length of questionnaires. Triads test data were analysed by computing aggregate proximities (similarities) between the varieties. To better delimit the boundaries between sub-groups of similar varieties, these results were subjected to cluster analysis using the ANTHROPAC 4.983/X parameter of maximum distance between similar items called the complete linkage approach, where the distance between two varieties in a cluster is based on the maximum distance (smallest similarity) between varieties. The results are presented in Figure 5.4.

In Koudandeng, the two HYVs are clustered together with other varieties. According to farmers' classification systems, large clusters consist of varieties that are either less salient among them or varieties that are newly introduced and thus not known by many farmers. Varieties with which farmers have greater experience and thus convey greater meaning to them are often placed in smaller distinct clusters or isolated as outliers.

In order to understand and explain the way farmers group order their cassava varieties, scores of the varietal attributes as perceived by farmers were computed and subjected to Property Fitting (PROFIT) regression with aggregate proximities (similarities) between the 15 and 10 varieties that were generated from the triads tests in Koudandeng and Malende respectively. The objective was to identify which dimensions or varietal attributes better explain the clusters observed in the cluster diagrams indicated in Figure 5.4 below. The results are depicted in Table 5.7.

The regression results depicted in Table 5.7 show that high palatability and seed exchange and labour saving/investment are statistically significant attributes ($p < .05$) that explain the variation and delimitations of the clusters as perceived by the more traditional Koudandeng farmers. Average yield is a weak statistically significant determinant of the delimitations of the clusters in Koudandeng. The more market oriented Malende farmers tend to have more significant attributes along which they classify their varieties: no susceptibility (tolerance) to cassava root rot disease, late maturity and long underground storage, good processing qualities and high palatability ($p \leq .05$; $p < .01$); and heritage and phenotype or morphology ($p < 0.1$). These results highlight the fact that yield is an important but not a significant local varietal evaluation reason for Malende farmers even though cassava is highly marketed here as compared to Koudandeng.

Figure 5.4 Johnsons' Hierarchical Clustering of Cassava Varieties by Koudandeng and Malende Farmers



It is hypothesised that in regions where cassava is highly marketed, yield is an important varietal selection criterion since farmers are more interested in a high turnover. The findings of this analysis contradict this hypothesis. Farmers in both villages differentiate between high, average, and low yielding varieties, which shows a continuum that is contrary to scientific classification of varieties as either high or low yielding.

Table 5.7 Regression Results from the Varieties Subjected to Triads Test

Varietal Attribute	*Malende*		*Koudandeng*	
	R^2	*Prob.*	*R^2*	*Prob.*
Research-introduced HYVs	-	-	0.234	0.411
Phenotype (colour and shape of parts)	0.546	0.078*	-	-
Phenotype: Colour of plant parts	-	-	0.358	0.126
Phenotype: Shape of plant parts	-	-	0.162	0.639
Crop management in field	0.419	0.183	-	-
High susceptibility root rot/other disease	0.336	0.281	0.260	0.335
Mod. susceptibility root rot/other disease	-	-	0.187	0.549
Not susceptible root rot/other disease	0.336	0.053**	0.040	0.928
High yield	0.022	0.831	0.342	0.171
Average yield	0.229	0.405	0.424	0.089*
Low yield	0.425	0.154	0.336	0.156
Late maturity, long underground storage	0.637	0.030**	0.267	0.300
Early maturity and no underground storage	0.347	0.254	0.245	0.342
Plant material availability	0.218	0.434	-	-
Dry season tolerance, plant material availability and varietal substitutability	-	-	0.103	0.676
Plant material scarcity	0.027	0.840	-	-
Ensuring household subsistence	0.452	0.125	-	-
Good processing qualities	0.528	0.046**	0.017	0.918
Poor processing qualities	0.239	0.457	0.210	0.465
Suitability for making specific products	0.377	0.178	0.073	0.806
High palatability	0.556	0.004***	0.528	0.028**
Low palatability	0.160	0.497	0.124	0.694
Ease of marketability and high income	0.238	0.424	0.324	0.189
Low marketability and low income	-	-	0.179	0.618
Source of income expenditure	0.196	0.500	-	-
Seed exchange, labour saving /investment	0.403	0.196	0.518	0.042**
Spiritual value	-	-	0.267	0.262
Heritage or landraces	0.390	0.093*	0.150	0.573

* = $p \leq .1$; ** = $p \leq .05$; *** $p < 01$

Classification of varieties according to visible attributes or phenotype is obvious in Malende since this is related to means of identifying varieties based on visible characteristics as is depicted in the names given to most varieties in this village (see Table 5.3 and Boster, 1985). As discussed earlier, names are related to the morphology of plant parts such as short branching, tall branching, Yellow cassava, Red skin, Red stick, and white stick.

Late maturation and long underground storage is rather a significant evaluation criterion for Malende farmers, but not for traditional Koudandeng farmers. The fact that moderate or no susceptibility to cassava root rot disease is significant among Malende and Koudandeng farmers implies that the disease is a problem and farmers seek varieties that are less susceptible to it. Varieties that store long underground are less susceptible to this disease and this further supports farmers' classification of varieties along the continuum of early to late maturation and long underground storability.

In like manner, good processing qualities are a significant attribute for Malende farmers because of high levels of gari processing and sales. One quality that is important to them is dry matter content, since this increases the amount of the desired end product, processed paste. According to farmers, high dry matter content is also closely related to long underground storability and late maturation, which are also significant attributes in Malende. One would have expected that processing qualities would also be significant for Koudandeng where cassava is the main staple, but its lack of significance may be more related to the fact that cassava is often boiled and eaten fresh or eaten raw as a labour saving strategy for women who are the main producers. This may be a reason why seed exchange and labour saving and palatability are significant evaluation criteria for Koudandeng farmers.

Furthermore, palatability is significant for both villages, but it is more significant for Malende. Palatability includes taste, colour, and texture of boiled fresh tubers and processed products and fresh tuber mealiness, and farmers depend upon consumer acceptance (good palatability) for processed product sales.

Detailed explanations for farmers' local varietal attributes are discussed in section 5.5, which relates these attributes to specific varieties and to the factors determining the variation in varietal classification among farmers.

Varietal clustering was done across farmers by age, family size, number of varieties grown, sex, household HIV/AIDS status, household headship and level of education (see Annex H for a summary of the clusters presented in table form). To further understand the variation in clustering across farmer sub-groups, farmers' varietal attributes were subjected to Property Fitting regression with the aggregate proximities data obtained from the analysis of triads test data across the different socioeconomic categories of farmers. The results of this analysis are found in Table 5.8, which show the significant attributes that appear to order varietal clustering across different farmer categories in the two villages. A general scan of the regression results shows that different farmer groups cluster their varieties based on their judgement of attributes that can be grouped into four major categories: agroecology, food security, food habits and culinary traditions (foodways), and livelihoods (income, labour). Varietal clustering in terms of cultural and spiritual values and in relation to research HYVs are specific for a few groups of farmers. Agroecological attributes include: phenotype (colour and shape of plant parts), pest and disease susceptibility (especially root rot), and yield. Food security related attributes are: maturation and harvesting age, underground storability, drought tolerance, varietal substitutability, plant material availability, and ensuring subsistence. Food habits and culinary traditions related attributes are: processing qualities, suitability for making specific products, and palatability. Livelihood attributes are marketability/income, income expenditure, seed exchange, and labour saving/investment. Spiritual values and heritage constitute cultural attributes.

These main and sub-attributes are, however, interrelated. For example, suitability for making specific products contains some aspects of processing qualities and palatability, while all three attributes are directly related to marketability.

Table 5.8 Significant Attributes that Order Cassava Variety Clustering across Farmer Socio-economic Categories* A. Koundandeng

Varietal Attribute	*Age of Farmer**				*Household Headship*				*Household Size*					
	Middle Age		*Elderly*		*Female Headed*		*Male Headed*		*Small*		*Medium*		*Large*	
	R^2	*Prob.*	*R^2*	*Prob.*	*R^2*	*Prob.*	*R^2*	*Prob.*	*R^2*	*Prob.*	*R^2*	*Prob.*	*R^2*	*Prob.*
Phenotype: colour of plant parts							0.425	0.07						
Phenotype: shape of plant parts														
Not susceptible to root rot and other diseases									0.533	0.00				
Moderate disease susceptibility	0.35	0.07												
High disease susceptibility			0.36	0.06										
Low yield	0.45	0.04	0.5	0.01										
Late maturity + long underground storage	0.34	0.09												
Early maturity + no underground storage			0.29	0.09							0.41	0.02		
Drought tolerance, varietal substitutability and plant material availability/unavailability														
Good processing qualities					0.41	0.09			0.389	0.02	0.29	0.09		
Poor processing qualities													0.38	0.04
Suitability for specific products														
High palatability							0.49	0.04						
Low palatability														
Ease of marketing/high income			0.37	0.04			0.44	0.08						
Low marketability/income														
Seed exchange + labour saving/investment					0.52	0.03	0.45	0.07					0.44	0.02
Spiritual value			0.24	0.08										

*Only those Farmer Categories and attributes that were significant are reported. "0.00" indicates values that were significant at the greater than 0.00 level.

Table 5.8 Significant Attributes that Order Cassava Variety Clustering across Farmer Socio-economic Categories (con't.) A.Koundandeng

Varietal Attribute	*Household HIV/AIDS Status*								*No. of Varieties Grown*						*Educational Status*					
	Not Affected		*Affected*		*Afflicted*		*Likely Afflicted*		*Grow Few*		*Average*		*Many*		*Illiterate*		*Basic (Primary) Level*		*Post Primary/ Secondary*	
	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*
Phenotype: colour of plant parts					0.42	0.02									0.45	0.03				
Not susceptible to root rot and other diseases					0.32	0.1			0.45	0.02							0.55	0.00		
High disease susceptibility					0.41	0.05											0.34	0.05	0.35	0.09
High yield					0.38	0.06							0.40	0.05						
Average yield													0.5	0.02						
Low yield									0.29	0.1							0.44	0.02		
Late maturity + long underground storage									0.45	0.03							0.4	0.06		
Early maturity + no underground storage	0.36	0.02			0.4	0.05			0.3	0.08									0.36	0.09
Drought tolerance, varietal substi-tutability and plant material avail-ability/ unavailability	0.3	0.1																		
Good processing qualities					0.32	0.07			0.48	0.00							0.45	0.01		
Poor processing qualities							0.48	0.01												
Suitability for specific products	0.3	0.06															0.49	0.01		
High palatability											0.41	0.09								
Low palatability	0.44	0.01	0.34	0.04																
Ease of marketing/high income					0.47	0.01									0.43	0.03				
Seed exchange + labour saving/investment							0.53	0.00							0.36	0.08				
Research HYVs							0.33	0.1												

*Only those Farmer Categories and attributes that were significant are reported. "0.00" indicates values that were significant at the greater than 0.00 level.

Table 5.8 **Significant Attributes that Order Cassava Variety Clustering across Farmer Socio-economic Categories (con't.)**
B. Malende

Varietal Attributes	*No. of Varieties Grown*						*Sex*			
	Few		*Average*		*Many*		*Women*		*Men*	
	R^2	*Prob.*	R^2	*Prob.*	R^2	*Prob.*	R^2	*Prob.*	R^2	*Prob.*
Phenotype (colour and shape)							0.741	0.016		
Crop management										
No susceptibility to root rot disease			0.648	0.078			0.681	0.001		
High susceptibility to root rot disease					0.598	0.046				
High yield										
Average yield			0.764	0.007						
Low yield			0.684	0.013			0.59	0.05		
Late maturity and long underground storage					0.657	0.036			0.542	0.051
Early maturity and no underground storage			0.473	0.053						
Plant material availability										
Plant material unavailability (scarcity)										
Ensuring household subsistence							0.518	0.089		
Good processing qualities							0.713	0.002		
Poor processing qualities										
Suitability for making specific products							0.526	0.068		
High palatability	0.436	0.041			0.677	0.015	0.534	0.039	0.455	0.021
Low palatability										
Marketability										
Income expenditure							0.483	0.095		
Seed exchange and labour saving							0.52	0.088		
Heritage									0.427	0.001

Table 5.8 **Significant Attributes that Order Cassava Variety Clustering across Farmer Socio-economic Categories (con't.)**
B. Malende

Varietal Attributes	*Ethnicity*																	
	Natives		*Moghamo/ Menemo*		*Bayangi*		*Bakossi*		*Bangwa*		*Tikari*		*Albo – Douala*		*Balondo – Ndian*		*Aghem/ Beba/ Modele*	
	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*	R^2	*Pr.*
Phenotype																		
Crop management															0.51	0.07		
No root rot			0.5	0.03					0.57	0.02	0.52	0.09						
High root rot							0.58	0.03										
High yield																		
Average yield															0.57	0.04		
Low yield									0.55	0.06							0.73	0.02
Late mat. long storage			0.61	0.02														
Early mat. no storage													0.49	0.02				
Plant material avail.																		
Plant material scarcity	0.63	0.07															0.78	0.03
Ensuring subsistence															0.54	0.07		
Good processing			0.58	0.00					0.51	0.08								
Poor processing															0.53	0.06	0.76	0.00
Suitability for products			0.64	0.00														
High palatability	0.48	0.09	0.51	0.01			0.41	0.05										
Low palatability									0.59	0.06					0.53	0.07	0.75	0.03
Marketability																		
Income expenditure																		
Seed exch. labour					0.53	0.09	0.55	0.04							0.49	0.08		
Heritage	0.41	0.09	0.43	0.00	0.39	0.09												

Underground storability and maturation/harvesting age are directly linked to agroecology in scientific classification systems, whereas farmers' view them more in terms of ensuring food security. These attributes are further discussed below in the section dealing with varieties that farmers actually grow.

Spiritual values are important because of the belief in Koudandeng where low yields are associated with the effect of witchcraft practices on individual's fields by other farmers and the Apoba moung and Fonctionnaire cassava varieties are believed to have special protective powers. Some elderly farmers in Koudandeng professed this belief. Seed exchange and labour are significant mainly for women in both villages (female household heads and women in male headed households, large households and farmers in HIV/AIDS likely afflicted households and illiterate farmers). It might be that the labour constraints of women farmers makes them tend to separate varieties that require high labour investment in growing, such as the HYV variety called Irad, from other varieties in Koudandeng and varieties with thick canopies that suppress weeds in farmers fields in Malende.

In summary, the above significant attributes could be grouped under agroecological (botanical), food security, food habits and culinary traditions (food and food ways), seed exchange, labour saving or investment and heritage.

5.4.6 Intra-cultural Variation by Significant Farmer Sub-groups

The seven farmer socio-economic attributes that were found to be significant in determining the diversity in knowledge of cassava varieties among farmers in the two villages are used below to discuss all of the dimensions examined above with respect to knowledge and, where data are interpretable, in varietal classification.

5.4.6.1 Ethnicity in Malende

While ethnicity is not a significant explanation for cassava varieties mentioned in Koudandeng, given that the sample did not include a sufficient number of cases of farmers in different ethnic groups, it is a significant explanation in ethnically diverse Malende (probability <0.001), where it accounts for 20.2% of the variation in the salience of the freelisted varieties. There, farmers belong to ten different ethnic groups: the Balong/Mbo/Bakundu (natives of the area), the Bameleke, the Meneno and Moghamo (all from Momo Division), the Tikari (from Bafut and Ndop), the Aghem/Modele (all from Wum), the Bayangi, the Bangwa, the Bakossi, and the Albo (from Douala), and the Balondo (from Ndian). However, the numbers of individuals falling into most of the ethnic groups is not high enough to permit statistical inferences to be drawn about any of the different ethnic sub-groups. What can be noted is that Kumba black stick and Red skin are highly salient among all ten groups, and Agric short branching is highly salient among seven out of the ten. Farmers of the Bameleke ethnic group in Malende do not have any specific attribute that order the classification of their varieties. This may be because these farmers have not had long-term experience with the varieties and so tend to see all attributes as important.

5.4.6.2 Farmer's age and family size in Koudandeng

According to the results of the PROFIT regression analysis in Table 5.6, age accounts for 11.8% of the variation in cassava varieties freelisted in Koudandeng. Three age categories were designated for Koudandeng: the young (≤ 42 years), the middle aged (43 - 58) and the elderly (59 to 75) (see Table 5.2). Farmers of all age groups know twelve of the most salient varieties. In relation to the average number of varieties listed, middle aged women named 12, which is above the average for all the 59 farmers studied (11), elderly women named 11, and young women 9. Middle age women generally have higher Smith's S scores and are closely followed by elderly women. Of the seven varieties having a salience index above 0.5, young and elderly women had scores on five and middle age women had scores on six. The young women mentioned a variety that had Smith's S scores below 0.5 for middle age and elderly women. These results indicate that middle age women tend to have somewhat greater knowledge compared especially with younger women, although not compared with the elderly.

The question remains as to whether there are any differences in the salience of the different varietal types among age groups. The two varieties that were introduced by research (Irad and Irad local) feature among the least salient for all age groups: Irad was salient only for young and middle aged women. All of the five most salient varieties among young women have a low cyanide content and are thus considered sweet, whereas one of the most salient varieties among middle aged and elderly women has a high cyanide content and thus is considered bitter. Four out of the 28 varieties that are listed in Koudandeng are bitter, and all four have varied salience index scores for all three age groups. All four bitter varieties have lower salience index scores for young women. Most young women interviewed said that they do not process cassava because they do not have time or do not like the bitter taste. Twelve varieties have been maintained for generations, all of which are salient among middle age and elderly women (three feature among the most salient), and eight of which are salient among young women.

The ways in which farmers of different age groups cluster varieties closely follows the pattern evident in the freelists. Young farmers group the varieties into two clusters, middle age farmers classify them into four, and elderly farmers classify them into three. While all three sub-groups have a distinct cluster that consists of only sweet varieties and another that combines both sweet and bitter, middle age and elderly farmers each have a distinct cluster that consists only of landraces. Young and middle age farmers consider that the two research HYVs are similar and group them together with other landraces, but the elderly farmers consider them to be dissimilar and thus group them into different clusters.

According to the PROFIT regression results shown in Table 5.6, eight per cent of the cassava diversity in Koudandeng is explained by the farmers' family size. Three size categories were used: i) small families with no more than five members (N=14), ii) medium families (5-10) (N=32) and iii) large families (>10) (N=13). Analysis show that medium size families named 93% of all varieties listed while farmers with large families named 82.1% of the varieties listed and farmers with small families named 78.6% of all the varieties. On average, farmers from large families listed 12.6 varieties, those from medium size families named 11.2, and those from small families listed 9.6.

Varietal knowledge generally increases with the size of the farmers' family, which is also related to the farmer's age. A cross tabulation of age by family size (Table 5.9) shows that farmers with small families are either young or old, while farmers with medium size and large households are mostly middle aged. It is likely that young farmers neither have many mouths to feed nor great financial responsibilities compared to middle aged farmers. Most elderly farmers do not have direct financial responsibilities for their adult children and grandchildren, and so plausibly they do not seek out new varieties if the existing varieties meet their needs.

Table 5.9 Family Size by Age by Number of Cassava Varieties Freelisted

Family Size	*Number of Cassava Varieties Known*			*Total*
	Age group 1 (≤42 years) N = 17	*Age group 2 (>42 ≤ 58 years) N = 28*	*Age group 3 (>58 years) N = 14*	
Small Families (≤5 members) N = 14	8.5%	10.2%	5.1%	14 (23.7%)
Medium Size Families (>5 ≤ 10 members) N = 32	16.9%	27.1%	10.2%	32 (54.3%)
Large Families (>10 members) N = 13	1.7%	11.9%	8.4%	13 (22%)
Total	17 (27.1%)	28 (49.2%)	14 (23.7%)	59 (100%)

It is possible that farmers of medium size and large households list many varieties because they have many mouths to feed and great family financial responsibilities, and thus seek varieties that can be boiled and eaten fresh, processed as well as those that are easily sold. Family size does not influence farmers' knowledge of the varieties that are introduced by research institutions because the two HYVs were salient among the farmers from small, medium and large families, even though with very low salience indexes. All 12 landraces are salient among medium and large families, while 11 landraces are salient among farmers with small families.

In summary, the differences between younger farmers, and middle age and older farmers (the majority of whom are women), are apparent both in terms of the total number of varieties listed and in terms of the most salient varieties. Although younger women are still quite knowledgeable about and value local landraces, they place a premium on sweet varieties compared with their older counterparts, and perhaps as they age they will 'catch up' with their elders with respect to varietal knowledge.

Farmers from small and large families in Koudandeng clustered their varieties into four clusters and medium seize families classify their varieties into five clusters.

Also, all three sub-groups consider the research HYVs to be dissimilar and thus cluster them in different clusters with other local and landrace varieties. All three groups cluster their varieties according to processing qualities. Tolerance to the root rot disease is an important clustering criterion for farmers with small families, which explains why they know fewer varieties compared to the other two sub-groups. The high family subsistence needs of farmers in medium size families may lead them to cluster their varieties according to early maturation and no underground storage. The labour demands of farmers from large families guide them to avoid varieties that require high labour input in crop management. "I do not grow Irad because it requires fertiliser application, which is a difficult and time consuming task," explained an elderly female farmer.

5.4.6.3 Household headship in Koudandeng

Two types of household headship exist in Koudandeng: female and dual headed households. Female headed households are those that are headed by either a widow or an unmarried woman. A dual headed household is one with both husband and wife. In Koudandeng, household headship accounts for 12.3% of the variation in naming cassava varieties (Table 5.6), where 12% of farmers from the cassava producing households interviewed are from female headed households and 88% are from dual (Table 5.1). Of the female headed households, 57.1% listed many varieties as compared to the 32.7% of the dual headed households. The proportion of farmers who listed few, an average number, and many varieties in dual headed households is almost the same in all three categories. On average, female household heads listed 13.1 varieties while women from dual headed households listed 10.7 (Table 5.10).

Table 5.10 Household Headship and Number of Cassava Varieties Known

Household Headship	*Total Number of Varieties Freelisted*			*Total*
	≤ 9	*10-12*	*≥ 13*	
Female headed N= 7	14.3%	28.6%	57.1%	100%
Dual headed N= 52	32.7%	34.6%	32.7%	100%
	Average Number Freelisted			
Female headed	9	11.5	15	13.1
Dual headed	9	12.3	15.4	10.7

What appears to be important in the distinction between types of households is the fact that female headed households on average appear to have greater knowledge of , and differentiate more between the varieties, which might be related to their overall greater level of household responsibility as providers of both sustenance and income, and as those who are solely responsible for crop production. Farmers in female headed households group the varieties into five clusters, and farmers in dual headed households classify them into four. The two research HYVs are considered dissimilar and thus are placed in different clusters by farmers from both household types. Farmers from female headed households also have a small distinct cluster that is made up of two landraces. Seed exchange and labour are significant clustering criteria for both female household heads and women in male headed households in Koudandeng. This might be related to their labour constraints as explained earlier. Also, following farmers' traditional seed exchange system in Koudandeng, women tend to group together valuable varieties that are used in gift giving to maintain kin and friendship ties. Women in male headed households base their evaluation criteria on palatability and marketability while female household heads look at processing qualities. Some palatability and processing qualities include root mealiness (cooking time, fibre) and taste, which are some how related to labour because Koudandeng women separate time saving varieties (good to boil and eat fresh and cook quickly) from those that must be processed.

5.4.6.4 Farmer's educational level in Koudandeng

Farmers' educational status is a significant ($p < .05$) determinant of and accounts for 12.5% of the variation in the listing of cassava varieties on farmers' freelists in Koudandeng (Table 5.6). Three categories of educational status were developed for ease of analysis: those who have never been to school (N= 11 or 18.6%), those who ever attended primary school or completed at most six years of schooling (N= 34 or 57.6%), and those who ever attended secondary school, attended a post primary school professional institution, and completed post-secondary education or had completed at least seven years of schooling (N= 14 or 23.7%). On average, farmers who had not been to school listed 10.273 varieties; those with a basic education listed 11.324 and those with post-primary education listed 11.417 varieties. In total, the group that named the most varieties (27) have some primary school education, closely followed by those with post-primary professional and secondary education (21), whereas those who have never been to school named only 18, which appears to indicate that education, however little, increases farmers' exposure to varietal knowledge.

The two HYVs are salient only among farmers with either primary or secondary school education or higher, and are not salient among farmers who never attended school (Table 5.14). Those with secondary education or higher scored higher (Smith's S for 18th variety = 0.066 and 19th variety = 0.063) for these varieties compared with primary school level farmers (Smith's S for 18th variety = 0.048 and 0.038 for 19th variety). With respect to the 12 landraces that have been maintained over generations, three are among the five most salient varieties for farmers who have never been to school and also among those with secondary school education and higher, while two are among the five most salient varieties for primary school level farmers.

Non-educated and primary educational level farmers classify the varieties they know into three clusters, whereas post primary educational level farmers classify them into four. Primary and post primary school level farmers both cluster the two research HYVs into different clusters, whereas the non-educated farmers cluster them together. All three sub-groups tend to cluster some landraces and sweet varieties into distinct clusters as well as lumping together sweet, bitter, and local varieties in larger clusters.

It appears that, in spite of the potentially greater exposure of more educated farmers to the HYVs, which also permits them to differentiate between these varieties' attributes; they continue to consider older landraces as highly significant. Some of the farmers in this group either interact individually with research or belong to a local organisation (Ayili) that has worked either with state and NGO extension institutions and have thus had greater exposure to the research HYV called Irad. The following are some of the responses that were given in relation to the source of the HYVs in Koudandeng "I obtained the Irad variety from a researcher when I attended a workshop that was organised at Irad Nkolbisson in Yaounde". "The Yellow cassava variety was introduced in Nkolfepe (a village neighbouring Koudandeng) by some researchers of ICRAF who created an experimental farm. Our common initiative group visited this farm and that is where I saw the Yellow cassava variety". Non-educated farmers are the least likely to be exposed to such varieties, which may partly explain the lower number of varieties that they freelisted.

Colour of plant parts and seed exchange and labour saving are significant clustering criteria for non-educated women farmers who are mainly the elderly (only one young woman). Colour of leaves is linked to the quality of kwem (pounded cassava leaves – the main vegetable relish) where white kwem is appetising and thus appreciated. Varieties with dark leaf colour such as Six mois amère are not preferred by farmers. Tuber peel colour is linked to attractiveness and thus marketability. Farmers perceive varieties with a red tuber peel as having low cyanide content and thus sweet, which attract customers and are easily sold and fetch higher income. Labour is a major constraint for these farmers because of age and some are widows who face the problem of lack of male labour in their production systems.

Susceptibility to root rot and early maturity and no underground storage are significant clustering criteria for the more highly educated farmers who are mostly young, may have not acquired enough experience with the varieties and most often do not process either because processing takes too much time or they do not have the necessary skills. The two men involved in cassava production in this research fall in this category that traditionally do not process nor sell cassava.

5.4.6.5 HIV/AIDS status in Koudandeng

The HIV/AIDS household status of farmers accounts for only 10.5% ($\rho < .05$) of the variation in the varieties listed in Koudandeng, and it may be an important but not a significant determinant of the variation in cassava variety listing in Malende (QAP regression results in Table 5.6). Four types of households were identified: non-afflicted households (N=37), affected households (N=3), afflicted households (N=12) and likely afflicted households (N = 7).

Tables 5.11 and 5.12 show that non-afflicted households listed the most varieties (N= 25), closely followed by HIV/AIDS afflicted households (N=23), while likely afflicted households occupy the third position (N= 21) and HIV/AIDS affected households named the fewest varieties (N=19). Farmers in HIV/AIDS afflicted and likely afflicted households respectively named 82.1% and 75% of the 28 varieties that were named, and ranked 2nd and 3rd respectively compared with farmers in non-afflicted households, who named 89.3%. Farmers in HIV/AIDS affected households named 67.9% of the varieties that are listed in this village. On the average, except for the HIV/AIDS likely afflicted households where farmers listed 11.14 varieties, all the other three sub-groups listed 11 varieties each. Of all the 12 landraces, non-afflicted households listed all, while 11 were salient among afflicted and likely afflicted households. All two research HYVs are salient among all four categories of HIV/AIDS household status although with very low indexes. The number of households contained in the subcategory 'affected' is, however, too small to permit meaningful comparison of varietal clusters or to draw strong conclusions about the relative importance of different groups of varieties (e.g. bitter versus sweet varieties) to this group.

In relation to clustering by Household HIV/AIDS status, Figure 5.5 shows that farmers in non-afflicted households group their varieties into four clusters while those in afflicted and likely afflicted households cluster their varieties into three distinct clusters each. However, the content of each cluster differs per HIV/AIDS household category. There seems to be a distinction between specific land races that are put together and the research HYVs that are perceived to be similar with other local and land race varieties by all the household categories. This classification system may be related to the varietal attributes that fit the specific needs of farmers in these different categories of HIV/AIDS households.

Farmers in HIV/AIDS afflicted households cluster their varieties using many attributes as compared to those from non-afflicted and likely afflicted households (Table 5.8).

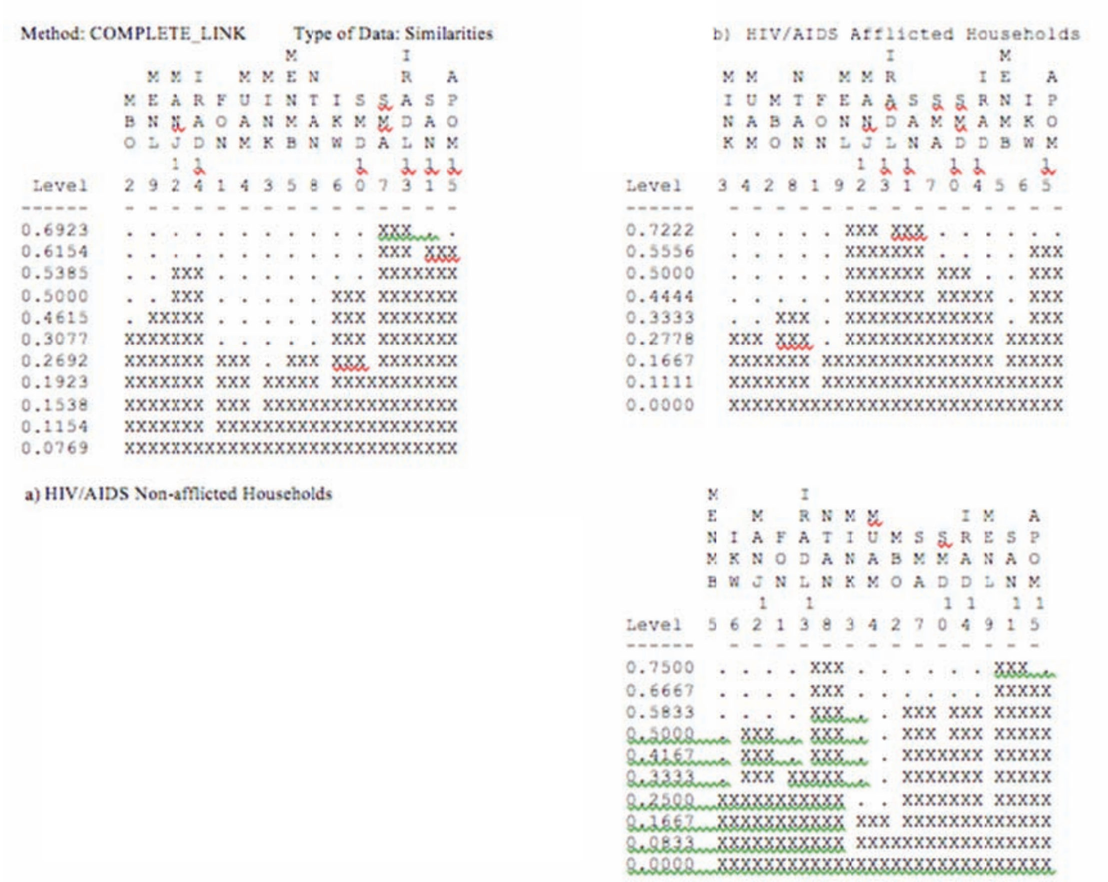
Table 5.11 Cassava Variety Salience by Household HIV/AIDS Status in Koudandeng

Variety	*Non-affected*	*Affected*	*Afflicted*	*Likely Afflicted*
Fonctionnaire feuilles verte	0.707	0.782	0.624	0.638
Fonctionnaire feuilles rouge	0.698	0.813	0.681	0.628
Mbokani	0.681	0.457	0.541	0.554
Mintole minko	0.541	0.625	0.545	0.561
Muane mong	0.512	0.381	0.552	0.618
Ikwemi	0.488	0.296	0.527	0.643
Menyo Mbandjock	0.441	0.451	0.621	0.272
Six mois amere	0.400	0.326	0.361	0.385
Ntange thick skin	0.279	0.346	0.246	0.251
Ntange thin skin	0.249	0.364	0.216	0.241
Six mois doux	0.221	0.078	0.257	0.304
Menyo local	0.263	0.02	0.119	0.184
Sanegai	0.118	0.377	0.195	0.192
Mekoughe	0.134	0.157		0.102
Mekoughe congo	0.098	0.255	0.086	
Moung eligedja nange	0.014		0.083	0.183
Meboura	0.041		0.058	0.078
Irad	0.014	0.137	0.117	0.01
Manioc jaune	0.041	0.039	0.012	0.038
Zayabo ayi madje	0.025		0.014	
Zama				0.143
Isanga	0.003	0.074	0.045	
Apoba moung	0.018		0.015	
Atanghai			0.056	
Nkoduma	0.002	0.059		0.048
Mbembong			0.038	
Irad local	0.011			
Shicago	0.004			

Table 5.12 Percent of Households in each Category of HIV/AIDS by Number of Cassava Varieties Freelisted

HIV/AIDS Household Status	*Number of Cassava Varieties Listed*			*Total*
	≤ 9 Varieties	*9 to 13 Varieties*	*≥ 13 Varieties*	
Non- afflicted N = 37	32.4%	35.2%	32.4%	100%
Affected N = 3	66.7%	-	33.3%	100%
Afflicted N = 12	25%	41.7%	33.3%	100%
Likely Afflicted N = 7	28.6%	28.6%	42.8%	100%

Figure 5.5 Johnson's Hierarchical Clustering by Household HIV/AIDS Status



Legend:

Fonctionnaire..FON
Mbokani..MBO**
Menyo local..MENL**
Manioc jaune ....MANJ*
IRAD...IRAD *
Muane moung...MUAM**
Mintole minko...MINK**
Menyo mbandjock..MENMB
* = Research HYV
** = Landraces

Ikwemi..............................IKW
Six mois doux.......................SMD**
Six mois Amère.....................SMA**
IRAD local...........................IRADL
Sanegai...............................SAN
Apoba moung........................APOM**
Ntangne...............................NTAN**

Early maturation, underground storability and processing qualities are common for HIV/AIDS afflicted and either one or two of the other two categories. Root rot susceptibility, yield, colour of plant parts and marketability are important elements for farmers in afflicted households while seed exchange and labour saving is also important for farmers in likely afflicted households. It is likely that farmers in HIV/AIDS afflicted and likely afflicted households are either elderly or of middle age and have large families. They thus have many mouths to feed and/or take off most of the time and labour required in farming activities to take care of the sick members of their households or themselves if they are victims. As such, they tend to separate varieties that are less susceptible to the root rot disease and thus are high yielding, good to boil and eat fresh and cook quickly, and do not require high labour investment in production. In this case, palatability is no longer an important option and early maturing varieties save them from starvation and make them more food secure. Their income expenditure needs also lead them to select varieties that are easily marketable.

5.4.6.6 Sex of farmers in Malende

Cassava is almost exclusively managed by women in Koudandeng (only two cassava producers are male), so sex-disaggregated analysis wasn't performed for this village. A PROFIT regression analysis (Table 5.6) of farmers' socio-economic attributes with their cassava freelist data did not show that sex of the farmers was significant in Malende ($p = 0.752$ for Malende). However, analysing the variation in the varieties that were freelisted by sex of the informant may still provide some useful insights, which will be cross referenced with other topics in this dissertation that are related to food security, agroecology, and livelihoods and labour that are discussed in the other chapters.

According to Table 5.13, in Koudendang, the two male cassava farmers listed 15 cassava varieties while women listed 28, or all that were listed in the locality. The men listed on average 10.5 varieties, while women on average listed 11.035 varieties. Apart from the variety called Six mois amère (six months bitter), the 14 varieties listed by the men are sweet, that this, they are non-toxic and can be boiled and eaten fresh.

Koudandeng women list both sweet and bitter varieties because they are the main growers, processors, marketers, and are responsible for food preparation. The HYVs that are known, Irad and Manioc jaune (Yellow cassava), have very low salience index among both male and female farmers.

Analysis of the freelist data obtained in Malende shows that men listed a total of 14 cassava varieties and women listed 11 (Table 5.14). Two men listed eight varieties as compared to women, which explains why men's total was greater compared to that of women. On average, however, men and women know the same number of varieties: male farmers listed four varieties on average, while female farmers listed 4.147. A discussion with the two men who listed more than the average number of varieties revealed that one of them is a member of the executive bureau of the Union of Cassava Farmers for the Fako administrative division in the South West Province, which was created in 2002, with the facilitation of the extension institution – the National Agricultural Extension and Research Programme (NAERP). The other male farmer is a native of Balong (the tribe to which Malende belongs) where cassava is among the top staple crops.

Of the 16 varieties listed in Malende, Kumba black stick is the most salient among both women and men (Table 5.14) and is closely followed by Agric short branching, presumably because these are the main varieties that are processed into gari, which is the main cassava product sold. The Red skin variety, which is the third most salient, is boiled and eaten fresh or pounded into a paste called water fufu and eaten with a relish. Even though 75% of the women and 43% of the men mentioned it, it has a lower salience index because cassava is not the dietary staple. Agric tall branching and Kumba white stick are also salient among women because these are also processed into gari.

The hypothesis that the increased involvement of men in cassava production as a source of income would imply a stronger male preference for HYVs, whereas women remain oriented toward local varieties is thus not in evidence of the freelist data. Men and women alike know the HYVs as well as the local varieties, and therefore it can be presumed that women are also commercially oriented, but this must be examined in relation to the varieties that each sex actually grows, discussed below.

Further, examining the differences between men and women's evaluation systems more qualitatively might provide some useful insights into gender differences later on and so are reported here. Both men and women cluster varieties into two clusters each at the same level of clustering (iteration), but with different combinations of varieties (Figure 5.6). Men cluster two of the most salient research HYVs together with Kumba black stick, while the two less salient ones are grouped together with other varieties. Women consider the most salient research HYV to be dissimilar to the other three research HYVs, but more similar to Yaounde, whereas Kumba black stick, which is the most salient variety in this village, is an outlier.

Table 5.13 Koudandeng Men and Women's Cassava Varietal Salience Index

No.	*Variety*	*Men's Varietal List*		*Women's Varietal List*	
		Freq. (N = 2)	*Smiths' S*	*Freq. (N = 57)*	*Smiths' S*
1	Fonctionnaire feuilles vertes	2	0.643	53	0.687
2	Fonctionnaire feuilles rouge	2	0.679	54	0.681
3	Mbokani (Gabon or Batouri)	1	0.357	56	0.647
4	Mintole minko*	1	0.393	51	0.554
5	Muane moung	1	0.357	43	0.532
6	Ikwemi	2	0.857	48	0.486
7	Menyo mbandjock (Ndongo esombe or Adjudi	2	0.750	45	0.444
8	Six mois (mevina) amère	2	0.214	50	0.392
9	Ntangne (Bela mpeughe) thick skin	1	0.214	31	0.274
10	Ntangne (Bela mpeughe) thin skin	1	0.179	30	0.250
11	Six mois (mevina) doux	2	0.571	30	0.219
12	Menyo local			31	0.218
13	Sanegai (obala)	1	0.321	24	0.150
14	Mekoughe			17	0.108
15	Mekoughe congo (amère) *			12	0.095
16	Moung eligedja nanga			5	0.048
17	Meboura	1	0.071	13	0.046
18	Irad * [2]	1	0.107	11	0.039
19	Manioc jaune [2]	1	0.036	7	0.034
20	Zayabo ayi madje			4	0.019
21	Zama			1	0.018
22	Isanga			3	0.016
23	Apoba moung			3	0.015
24	Atangai			1	0.012
25	Nkoduma (Muane moung de douala)			3	0.01
26	Mbembong			1	0.008
27	Irad local *			1	0.007
28	Shicago			1	0.002

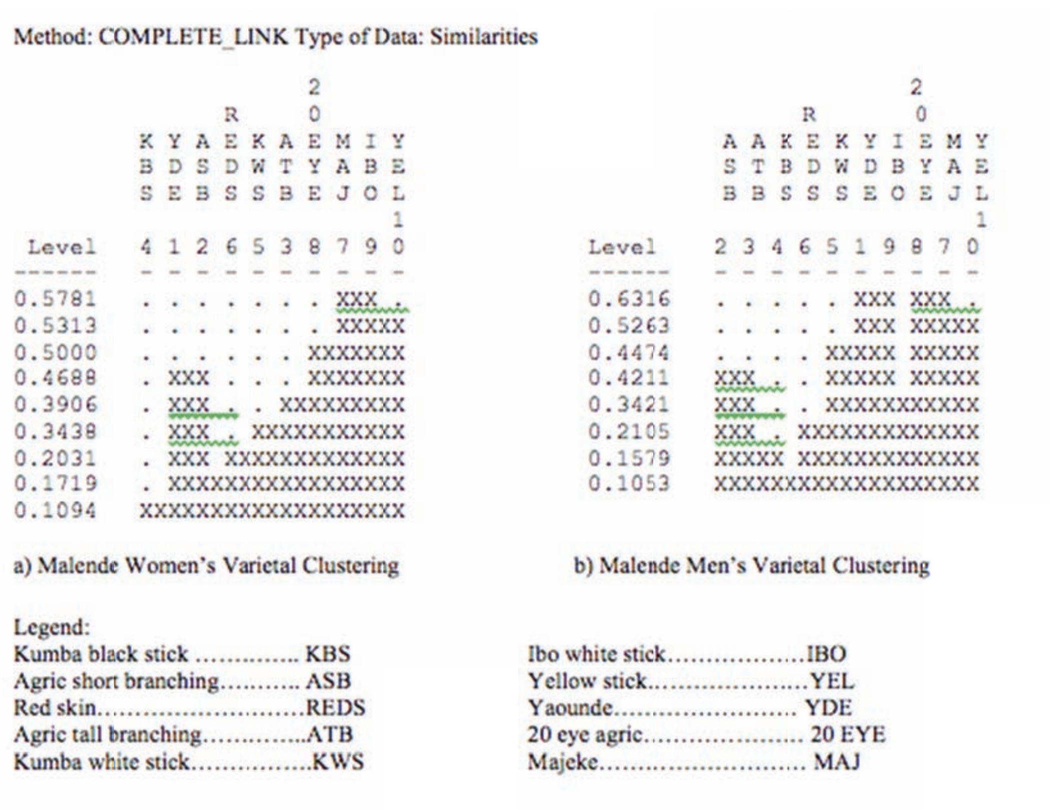
* = Bitter varieties; [2] = Reseach-introduced varieties

Table 5.14 Malende Men and Women's Cassava Varietal Salience Index

No.	*Variety*	*Men's Varietal List*		*Women's Varietal List*	
		Freq. (N = 21)	*Smiths' S*	*Freq. (N = 34)*	*Smiths' S*
1	Kumba black stick	21	0.827	34	0.830
2	Aric short branching ²	17	0.629	31	0.626
3	Red skin *	16	0.340	27	0.382
4	Agric tall branching ²	9	0.252	17	0.275
5	Red stick short branching *	7	0.155	9	0.115
6	Kumba white stick	5	0.152	14	0.234
7	20 eye agric ²	2	0.037	1	0.015
8	Majeke	1	0.030		
9	Melon stick	1	0.012	2	0.020
10	Yaounde *	1	0.024	4	0.066
11	Yabassi	1	0.018		
12	Black stem Susan	1	0.012		
13	Black stick Mile 40			1	0.006
14	Yellow stem ²			1	0.005
15	Old stick	1	0.006		
16	Ibo white stick	1	0.006		

² = Reseach-introduced varieties * = Sweet varieties

Figure 5.6 Johnson's Hierarchical Clustering by Sex in Malende



Method: COMPLETE_LINK Type of Data: Similarities

```
                        2
                R       0
          K Y A E K A E M I Y
          B D S D W T Y A B E
          S E B S S B E J O L
                            1
 Level    4 1 2 6 5 3 8 7 9 0
 ------   - - - - - - - - - -
 0.5781   . . . . . . . XXX .
 0.5313   . . . . . . . XXXXX
 0.5000   . . . . . . XXXXXXX
 0.4688   . XXX . . . XXXXXXX
 0.3906   . XXX . . XXXXXXXXX
 0.3438   . XXX . XXXXXXXXXXX
 0.2031   . XXX XXXXXXXXXXXXX
 0.1719   . XXXXXXXXXXXXXXXXX
 0.1094   XXXXXXXXXXXXXXXXXXX
```

a) Malende Women's Varietal Clustering

```
                        2
                R       0
          A A K E K Y I E M Y
          S T B D W D B Y A E
          B B S S S E O E J L
                            1
 Level    2 3 4 6 5 1 9 8 7 0
 ------   - - - - - - - - - -
 0.6316   . . . . . . XXX XXX .
 0.5263   . . . . . . XXX XXXXX
 0.4474   . . . . . XXXXX XXXXX
 0.4211   XXX . . XXXXX XXXXX
 0.3421   XXX . . XXXXXXXXXXX
 0.2105   XXX . XXXXXXXXXXXXX
 0.1579   XXXXX XXXXXXXXXXXXX
 0.1053   XXXXXXXXXXXXXXXXXXX
```

b) Malende Men's Varietal Clustering

Legend:

Kumba black stick .... KBS
Agric short branching........... ASB
Red skin...........................REDS
Agric tall branching..............ATB
Kumba white stick.................KWS
Ibo white stick..................IBO
Yellow stick.....................YEL
Yaounde........................ YDE
20 eye agric..................... 20 EYE
Majeke.......................... MAJ

In the more commercial oriented Malende, where men are increasingly taking up cassava production (38.2%), early maturity and no underground storability, palatability and heritage are salient attributes among men. Interviews with some male farmers showed that late maturing varieties are not preferred because men are more interested in rapid turn over. Men understand palatability in terms of the taste and colour of processed products, which is obvious because they eat cassava. Some of the men have had greater exposure to extension and research institutions and are used to the scientific classification of local versus research improved varieties and some of them are natives who value their landraces, which they call the oldest varieties. Women as producers, main processors and marketers of cassava and insurers of family subsistence tend to look at attributes that facilitate their achievement of these functions.

They therefore cluster their varieties in terms of phenotype, which permit them to differentiate between the varieties, susceptibility to root rot, which reduces yield, yield, ensuring household subsistence, processing and suitability for making specific products. Marketability may not be significant, but it is determined in terms of the qualities of the processed products and suitability of making gari and water fufu for sale. Processing qualities in this case include dry matter content of the fresh tubers, which is closely linked to the weight and volume of the processed product, and colour and texture of the processed product. Income expenditure is significant for women because the cassava seed or plant material is increasingly being commercialised in Malende and so scarce and valuable varieties require purchasing. Labour is an important constraint and labour hiring is employed more in processing and field clearing, so women group separately those varieties with thick canopies that suppress weeds in the fields.

5.5 Varieties Grown, Varietal Attributes and Clusters

5.5.1 Freelisting and Number of Varieties Grown

The data in relation to the number of cassava varieties actually grown as compared to those that farmers named in their freelists were obtained from a followup question to the freelisting exercise, where farmers were asked to name which of the varieties that they had listed they had also grown during the year prior to the interview. These were tallied to obtain a farmer–by-variety grown matrix, which was subjected to property fitting regression with farmers' dichotomised freelist data. As indicated in Table 5.6, the PROFIT regression results show that the number of varieties grown is a significant ($p < 0.01$ for Koudandeng, $p = 0.001$ for Malende) explanation for the variation in the freelists in both Koudandeng and Malende (18.3% and 33.1% of the variation in the freelists, respectively).

For ease of analysis, farmers were grouped into the following categories: those who cultivated few varieties (≤2 in Malende, ≤5 in Koudandeng), those who cultivated an average number (3 to 4 for Malende, 6 to 8 for Koudandeng) and those who cultivated many (>5 for Malende, >8 for Koudandeng). In Malende, the six most salient varieties according to the freelists are common among each farmer category (see Figure 5.7), and all the fourteen most salient varieties in Koudandeng are also common among all categories of cultivators (Figure 5.8).

In Koudandeng, on average, those who grow few varieties listed 9.429 varieties, those who grow an average number of varieties listed 11.174 and those who grow many varieties listed 13.

Figure 5.7 Malende Farmers' Freelisted Cassava Variety Salience by Number of Varieties Grown

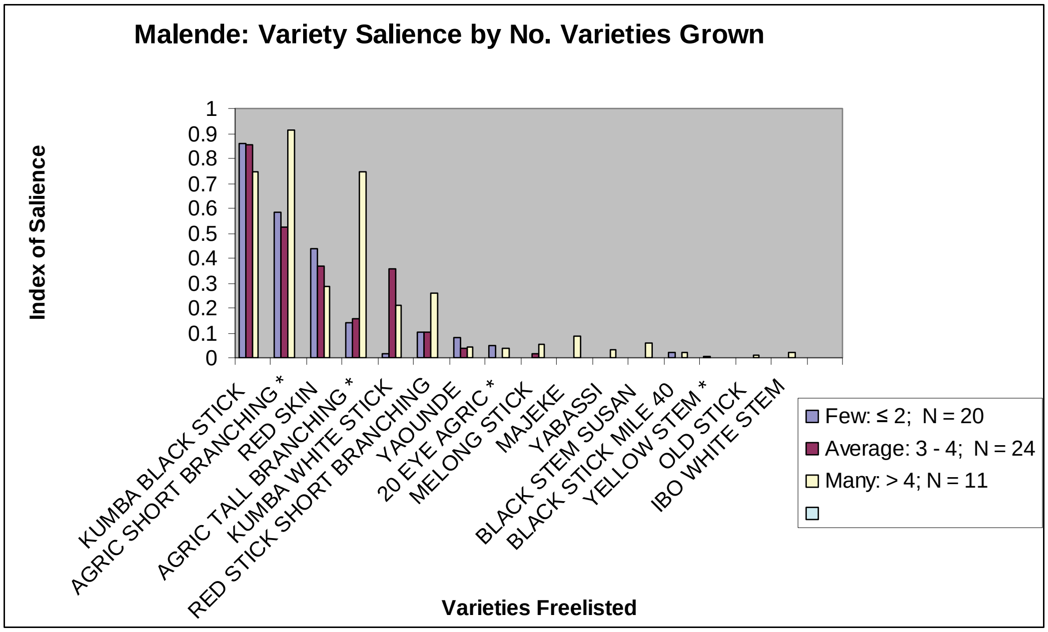
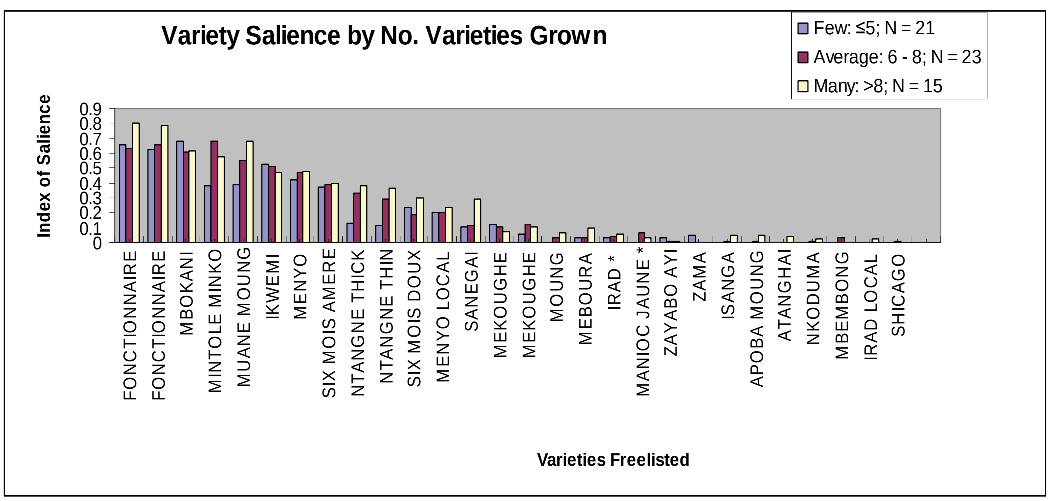


Figure 5.8 Koudandeng Farmers' Freelisted Cassava Variety Salience by Number of Varieties Grown in 2007



In Malende, the trend is similar where on the average, those who grow few varieties listed 3.6 varieties, those who grow an average number of varieties listed 3.833 varieties and those who grow many varieties listed 6.09. Thus the number of varieties that are known increases with the number of varieties grown in both villages. The number of landraces named also followed the same trend in Koudandeng. In Malende, two of the four reseach-introduced varieties are highly salient among farmers who grow many varieties, while only the Agric short variety has high salience among those who grow few and an average number of varieties. Although may women farmers in Malende listed Agric tall branching, it was less salient than Agric short branching because of its perceived low yields. “I do not grow Agric tall because it does not produce well”. “I used to grow Agric tall branching before, but I abandoned it two years ago because it does not yield well on old soils” are some of the answers given by women and men farmers in response to the question on which cassava variety they grow or do not grow. Only one woman mentioned Yellow stem, an HYV which was introduced by research institutions, which shows the level of its rejection among the farmers. Previous research in Malende in 1997 showed that over 20% of farmers knew this Yellow cassava variety even though they did not grow it (Nchang Ntumngia, 1997). The variety called 20 eye agric seems to be one of the varieties that IITA recently introduced that is disseminated by the Root and Tuber Market Oriented Programme (PNDRT is its French acronym) of the Ministry of Agriculture and Rural Development, but it was mentioned by only two men and one woman. The woman who mentioned it is the wife of one of the male farmers. In Koudandeng, both of the HYVs have low salience scores among all three categories of farmers. Cassava is the main staple and has more associated values compared to fewer values in the more commercially oriented village.

It can be concluded that, in spite of farmers’ production orientation, varietal salience, knowledge and diversity generally increase with the number of varieties managed by farmers. This may be the result of the multiple values or meaningfulness that the different varieties have for farmers even though these may be more for farmers whose main staple is cassava.

5.5.2 Perception of Varieties Actually Grown

When we talk of diversity, we do not limit our analysis only to those varieties that were used for the triads test, but to all of the other varieties that were mentioned in both villages as well. Also, the fact that one variety is not very salient among farmers does not mean that it is not meaningful or important; a variety may not be very salient because it is either new or has greater meaning only for a particular sub-group of farmers or for individuals. Tables 5.15 and 5.16 summarise the attributes, as farmers perceive them, of all 28 varieties in Koudandeng and the 16 varieties in Malende. Detailed information on each variety and its related attributes as discussed by farmers is included as Appendix H. In the two tables below, the column that appears immediately after the varietal attribute has figures with either a positive or a negative sign, or a zero (neutral sign) to specify the magnitude or degree of meaning that each varietal attribute has for the farmers. While some varietal attributes may be considered by some farmers to be negative, others may see these same attributes positively, and such attributes are therefore considered, on aggregate, to have neutral significance to farmers.

Table 5.15 Varietal Attributes as Perceived by Koundandeng Farmers

				Varietal Name									
Class	*Attribute type*	*Attribute group*	*Pos / Neg value*	*Fonct. feuilles verte*	*Fonc. feuilles rouge*	*Mbokani*	*Mintole minko*	*Muane moung*	*Ikwemi*	*Menyo mband-jock*	*Six mois amère*	*Ntangne thin skin*	*Ntangne thin skin*
Agroecology	Phenotype (morphology)	Colour of plant parts	1	11	16	3	2	1	1	12	4	0	0
		Shape of plant parts	1	0	0	2	0	0	2	7	0	1	1
		Research introduced	1	0	0	0	0	0	0	0	0	0	0
		Total phenotype	1	11	16	5	2	1	3	19	4	1	1
	Pest and diseases	High root rot	-1	32	32	16	10	2	9	26	9	3	3
		Moderate rot	0	1	1	11	3	2	3	1	1	0	0
		Does not rot	1	1	1	0	4	1	3	1	0	1	1
	Yield	High yield	1	83	87	55	34	50	33	33	24	30	30
		Average yield	1	3	3	5	0	9	1	0	1	6	6
		Low yield	-1	9	9	20	11	7	8	7	4	10	11
Food security	Maturation, harvest age and storage	Early maturity/ harvest & doesn't store long	0	72	71	11	4	5	2	17	30	2	2
		Late maturity & stores long underground	1	0	0	37	20	16	19	7	0	15	15
	Drought tolerance, substitutability and availability		0	3	3	5	3	3	5	0	5	0	0
Foodways	Processing qualities	Good	1	6	7	10	19	11	52	19	4	7	7
		Poor	-1	0	0	0	0	0	11	2	5	2	2
	Palatability	High palatability	1	71	72	140	58	127	69	81	17	65	65
		Low palatability	-1	8	8	9	39	0	18	5	44	2	2
	Suitability for processed products		1	13	15	25	98	18	111	12	54	14	14
Livelihood and culture	Income	High marketability	1	39	39	6	7	3	16	54	1	6	6
		Low marketability	-1	0	0	4	1	0	0	0	0	0	0
	Seed exchange and labour saving		1	0	0	0	0	0	1	0	1	0	0
	Spiritual value		1	2	2	0	0	0	0	0	1	0	0
	Heritage value		1	0	0	7	21	25	0	0	7	18	18

Table 5.15 Varietal Attributes as Perceived by Koundandeng Farmers (con't.)

Class	*Attribute type*	*Attribute group*	*Pos / Neg value*	*Six mois doux*	*Menyo local*	*Sanegai*	*Mekoughe*	*Mekoughe congo*	*Moung eligedja nanga*	*Meboura*	*Irad*	*Manioc jaune*	*Zayabo ayi madje*
Agroecology	Phenotype (morphology)	Colour of plant parts	1	2	5	1	2	2	0	2	1	0	0
		Shape of plant parts	1	0	1	0	1	0	0	0	1	0	0
		Research introduced	1	0	0	0	0	0	0	0	1	1	0
		Total phenotype	1	2	6	1	3	2	0	2	2	0	0
	Pest and diseases	High root rot & other dis-	-1	7	7	8	4	0	1	2	8	2	0
		Moderate rot	0	0	1	0	0	0	0	1	0	0	0
		Does not rot	1	0	0	0	0	0	0	0	0	0	0
	Yield	High yield	1	14	14	23	3	4	8	4	11	0	2
		Average yield	1	0	3	1	2	0	0	0	0	0	0
		Low yield	-1	4	9	3	4	3	0	1	4	3	0
Food security	Maturation, harvest age and storage	Early maturity/harvest & does not store long under-ground	0	25	1	6	4	1	5	0	5	1	1
		Late maturity &stores long underground	1	0	6	1	3	1	0	7	0	0	0
	Drought tolerance, substitutability and avail-ability		0	2	1	4	1	1	0	1	1	1	0
Foodways	Processing qualities	Good	1	2	8	5	2	2	1	6	1	0	0
		Poor	-1	7	1	2	0	0	0	1	18	0	0
	Palatability	High palatability	1	38	44	29	0	0	6	43	17	3	2
		Low palatability	-1	7	4	3	0	4	1	2	13	3	0
	Suitability for processed products		1	12	10	6	8	3	1	2	23	0	0
Livelihood and culture	Income	High marketability	1	0	26	4	0	1	0	11	0	0	0
		Low marketability	-1	0	0	0	0	0	0	0	1	0	0
	Seed exchange and labour saving		1	0	0	0	0	0	0	0	1	0	0
	Spiritual value		1	0	0	0	0	0	0	0	0	0	0
	Heritage value		1	7	2	5	13	8	0	10	0	0	0

Class	*Attribute type*	*Attribute group*	*pos /neg value*	*Zama*	*Isanga*	*Apoba moung*	*Atangai*	*Nkoduma*	*Mbembong*	*Irad local*	*Shicago*
Agroecology	Phenotype (morphology)	Colour of plant parts	1	0	0	0	0	0	0	0	0
		Shape of plant parts	1	0	0	0	0	0	1	0	0
		Research introduced	1	0	0	0	0	0	0	0	0
		Total phenotype	1	0	0	0	0	0	1	0	0
	Pest and disease susceptibility	High root rot & other diseases	-1	0	0	2	0	0	0	0	0
		Moderate rot	0	0	0	0	0	0	0	0	0
		Does not rot	1	0	0	0	0	0	0	0	0
	Yield	High yield	1	2	0	3	1	1	1	1	0
		Average yield	1	0	0	0	0	0	0	0	0
		Low yield	-1	0	0	1	0	0	0	0	0
Food securi-ty	Maturation, harvest age and storage	Early maturity/harvest & does not store long underground	0	0	0	0	0	0	0	3	0
		Late maturity & stores long underground	1	1	0	2	0	0	0	0	0
	Drought tolerance, substitutability and availability		0	1	0	4	0	0	0	0	0
Foodways	Processing qualities	Good	1	0	0	0	0	0	0	2	0
		Poor	-1	0	0	0	0	0	0	2	0
	Palatability	High	1	0	3	9	0	3	0	0	0
		Low	-1	0	0	2	0	0	0	7	0
	Suitability for processed products		1	0	0	2	2	2	0	2	0
Livelihood and culture	Income	High marketability	1	0	0	0	0	0	0	0	0
		Low marketability	-1	0	0	0	0	0	0	0	0
	Seed exchange and labour saving		1	0	0	0	0	0	0	0	0
	Spiritual value		1	0	0	11	0	0	0	0	0
	Heritage value		1	0	0	15	0	9	0	0	0

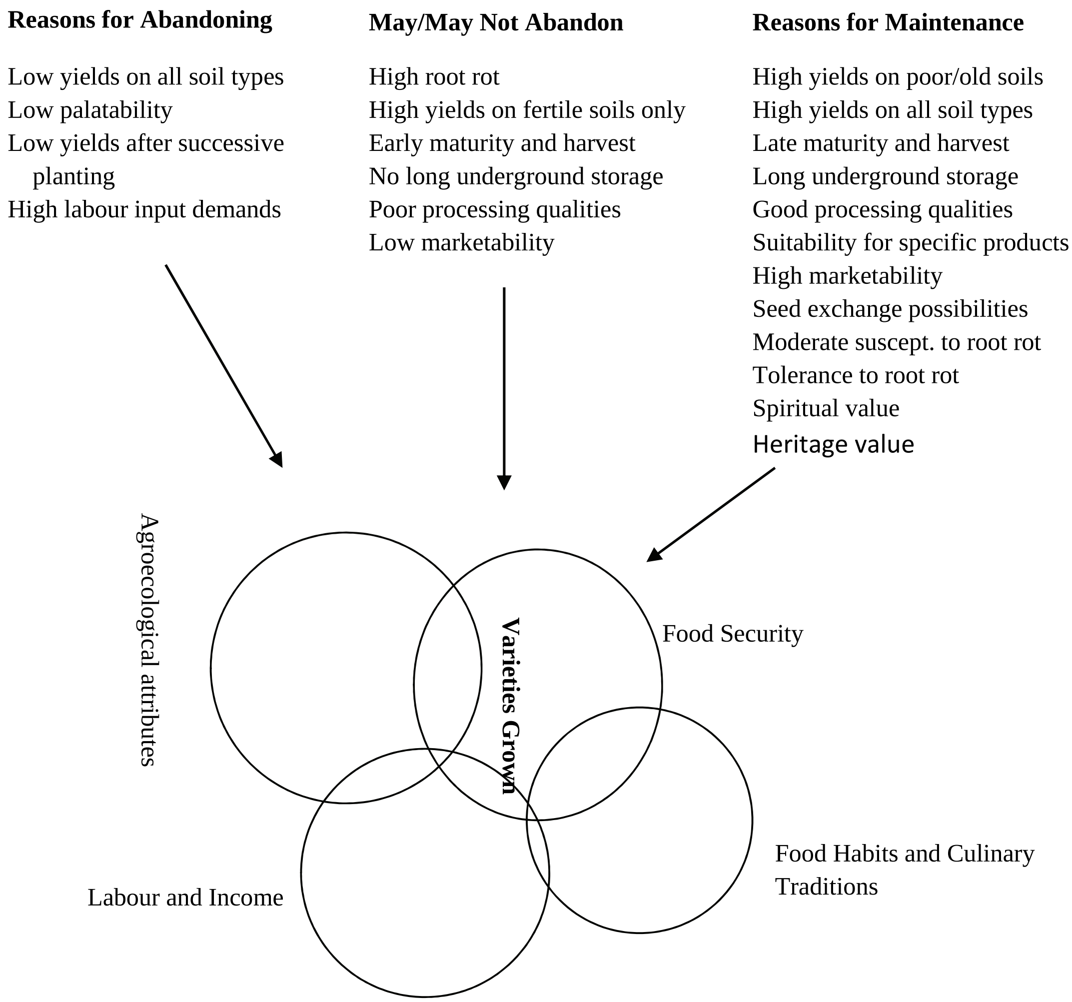
For example, in Koudandeng, early maturation has a neutral sign because, while some farmers think that early maturing varieties guard against hunger, other farmers do not prefer such varieties because of the influence of cultural beliefs. According to some women, when early maturing varieties are harvested, one's fields look empty, which leads to mockery on the part of other women, who consider that those who have empty fields are lazy. Also, early harvesting invites thievery because some women prefer stealing plant material from neighbour's fields rather than begging due to the common belief that associates poor yields with the actions of witches on others' fields. This is one of the reasons for the scarcity of some varieties, especially Apoba moung, that farmers mentioned. On the contrary, all farmers in Malende see early maturation positively because it permits quick turnover. Other attributes that have neutral implications among Koudandeng farmers include moderate susceptibility to root rot (as opposed to high or low susceptibility), tolerance of dry conditions, varietal substitutability, and availability. A variety that is moderately susceptible to root rot may or may not be abandoned.While some farmers find tolerance to dryness to be a positive attribute (leaves are tolerant to the effect of the dry season, which means that the leaves for making kwem (the main vegetable source) will continue to be produced, other farmers think that this attribute is not necessarily very important because any other variety can be manipulated to produce enough leaves (by breaking off leaf tips at the end of the rainy season, just prior to the dry season) to produce enough leaves and therefore kwem during the dry season.

While some varieties have high salience indexes because they are more meaningful to a majority of farmers, this does not necessarily imply that a less salient variety is not meaningful. Some varieties have high sores on specific attributes and low scores on other attributes. For example, in Koudandeng, the two Fonctionnaire varieties that are the two most salient out of the 28 varieties freelisted, have high values on yield (high yielding), but also score highest on susceptibility to root rot disease. Menyo mbandjock, which is the seventh most salient variety, has the highest value for marketability, but it ranks second only to Fonctionnaire with respect to susceptibility to root rot disease.

Among the least salient varieties,Meboura is highly palatable and marketable. Apoba moung has a high score for heritage and spiritual values, but its salience is 0.014. In relation to the research HYVs, the variety called Irad is considered to be high yielding but its processing qualities are considered to be poor because of its high water content, which shrinks the cassava paste when processed and therefore the volume of the processed product is less compared with other varieties. Nevertheless, it has a high value in relation to suitability for making specific products because, according to some farmers, the high water content makes processing easier and thus produces a soft and smooth paste, which improves the quality of the processed product. The Irad variety thus has some high scores for palatability. The variety called Manioc jaune (Yellow cassava) has low cyanide content and thus is sweet but, despite this, it is yellow, which is considered to be an unappetising colour, so that scores for palatability are low. In Malende, even though Ibo white stick is the least salient, it is high yielding and has good processing qualities. Despite the fact that the Red skin variety is less salient than the Agric short variety, the former ranks second to Kumba black stick with respect to good processing and palatability qualities because it is boiled and either eaten fresh with a relish or pounded into a thick paste called fufu and eaten with a relish.

Palatable varieties that are boiled and eaten fresh or pounded should have a good taste, be soft to chew (no or less fibre), be sticky or gelatinous and have a white and appetising colour. A variety that is processed is considered palatable if its processed product(s) has a good taste, is sticky or gelatinous when prepared into a meal and is white and shiny and thus appetising to eat and attractive to consumers. As explained by farmers, colour is an important determinant of the level of marketability of cassava varieties and related products. “It produces shiny gari. It gives white shiny waterfufu; its gari and waterfufu are gelatinous (drawing and sticky)” are some salient retorts by Malende farmers. While Koudandeng women will often say, “its couscous and baton are white, shiny and gelatinous; the white colour of its couscous attracts consumers; its tubers have a red colour, which attracts consumers and make it sell easily and quickly.” A schematic representation of the varietal attributes that order farmers’ decision-making frameworks and thus determine cassava varietal diversity is depicted in Figure 5.9.

Figure 5.9 Varietal Attributes influencing Farmers’ Decision Making Frameworks



5.6 Cassava Varietal Diversity and Factors that Influence Diversity

Having discussed farmers' knowledge of cassava varieties by looking at naming and the meaning behind naming, the salience of freelisted varieties, farmer socioeconomic attributes that influence the variation freelists, the local classification of the varieties and the attributes that order this classification across farmer sub-groups, it is still necessary to look at how such knowledge of the varieties relates to cassava diversity in farmers' fields. Varietal diversity here is discussed in terms of what farmers grow and the proportion of farmers growing each variety, comparing this with the salience of the varieties. The percent of farmers growing each variety was computed by tallying the scores of those who indicated that they were growing a variety in response to the follow up question to the freelisting exercise on whether they grew the variety or not during the year of the interview in each village. The scores for farmers growing each variety were then divided by the total number of farmers who participated in the freelisting exercise, and then standardised by multiplying by one hundred. This exercise was done across farmer sub-groups by sex in Malende and household HIV/AIDS status in Koudandeng. The salience indexes and percent of farmers growing each variety are presented in tables 5.17 and 5.18. These tables highlight the fact that, even though varieties are highly salient among farmers, this does not imply that they are widely grown by all categories of farmers. As indicated earlier, a variety may not be very salient because it is either new or has greater meaning only for a particular sub-group of farmers or individuals. For example, in Koudandeng, the variety called Ntangne, which is less salient compared to Six mois amère, was grown in 2007 by a greater percentage of the farmers (68.8% for Ntangne thick skin, 71% for Ntangne thin skin) who listed it, while Six mois amère was grown by only 42.3% of the farmers who mentioned it. Zayabo ayi madje, which appears among the 10 least salient varieties (0.018) in this village, was grown by 75% of all of the farmers who listed it. In Malende, Red skin, which was the third most salient (0.378), was grown by all the farmers who listed it in 2007, while Kumba black stick, the most salient, was grown by 83.6% and Agric short branching (the second most salient), was grown by 62.5%. Black stick Mile 40 and Old stick, which are among the least salient varieties, were grown by all of the farmers who listed them.

With respect to the research HYVs, the Irad variety, which was salient among 12 farmers, was grown by only one farmer (8.3%) who is from an HIV/AIDS afflicted household, and the Manioc jaune (Yellow cassava) variety, which was salient among eight farmers, was not grown by any farmer in Koudandeng. In Malende, the Agric short branching variety is the main research HYV that is grown by 54.5% farmers and is closely followed by the Agric tall branching variety that is grown by 30.9% of farmers. No farmer indicated that they grew the yellow stick variety in 2007 in both villages. Of the 13 research HYVs that were released among farmers in these two villages since 1986, only two are effectively being grown in the more commercial oriented Malende, while farmers of the more subsistence oriented Koudandeng have virtually abandoned them.

In relation to the landraces, the Old stick and the Red skin varieties were grown by all the Malende farmers who participated in the freelisting exercise. More than 50% of the farmers in Koudandeng were growing six out of the 12 listed landraces. Even though the variety called Apoba moung is a landrace and is greatly appreciated because of its spiritual powers, it is not grown because it is scarce.

Table 5.17 Percent of Households Growing Each Cassava Variety Freelisted in 2007 in Koudandeng

Variety Freelisted	*Freq.*	*Smith's S*	*Farmers Growing as % of Total N = 59*
Fonctionnaire feuilles verte	55	0.685	94.9
Fonctionnaire feuilles rouge	56	0.681	91.5
Mbokani **	57	0.637	86.4
Mintole minko **	52	0.549	55.9
Muane Moung **	44	0.526	67.8
Ikwemi	50	0.498	74.6
Menyo mbandjock	47	0.455	57.6
Six mois amère **	52	0.386	37.3
Ntangne thick skin **	32	0.272	37.3
Ntangne thin skin **	31	0.247	37.3
Six mois doux **	32	0.231	27.1
Menyo local **	31	0.211	27.1
Sanegai	25	0.155	23.7
Mekoughe **	17	0.104	8.5
Mekoughe congo **	12	0.092	5.1
Moung eligedja nanga	5	0.047	6.8
Meboura **	14	0.047	11.9
Irad*	12	0.041	1.7
Manioc jaune *	8	0.035	0.0
Zayabo ayi madje	4	0.018	5.1
Zama	1	0.017	1.7
Isanga	3	0.015	1.7
Apoba moung **	3	0.014	0.0
Atanghai	1	0.011	1.7
Nkoduma	3	0.009	3.4
Mbembong	1	0.008	1.7
Irad local	1	0.007	1.7
Shicago	1	0.002	0.0

* = HYV, ** = landrace

'Apoba moung was grown by our forefathers especially because it has spiritual powers to protect the fields from the wicked actions of witches who withdrew crops from other persons' fields, thus leading to low yields and poor harvests'. 'This variety no longer exists. Those who know its spiritual value are seriously looking for it. I hear that it is grown in Sa'a [a town in the Lekie Division], but we do not have it in Koudandeng,' were some of the common answers in response to why farmers who listed this variety do not grow it.

With regards to household HIV/AIDS status in Koudandeng, apart from the Six mois amère ($p<.1$), Nanga ($p=.05$) and Zama ($p<.05$) varieties where the difference in the percentage of farmers growing them for the different categories of HIV/AIDS households is significant, generally the difference between the percent of farmers growing each variety by household HIV/AIDS status is not significant. The observed differences are in relation to the types of varieties grown. HIV/AIDS afflicted and likely afflicted households mostly grow landraces and a few newly introduced local varieties of which only one - Mintole minko - is bitter. The only one growing the HYV called Irad in Koudandeng is from an afflicted household.

As regards the percentage of farmers growing each variety by sex, apart from the Kumba black stick where the difference is the percentage of men and women growing it is significant (p <.001), there is generally no significant difference in the percent male and female farmers growing all the varieties in Malende. However, the percentage of women growing the most salient local varieties is higher relative to the percentage of men, which is also higher in relation to growing the two most salient research HYVs as compared to the percent of women.

In summary, varietal salience may not be the most important determinant of varietal diversity among farmers even though it signifies the meaningfulness of each variety for farmers. The fact that some cassava varieties were not grown by a substantial number of those who listed them implies that either they are not available, as in the case of Apoba moung, or that they do not have the attributes that farmers look for. A number of variables or factors may account for this.

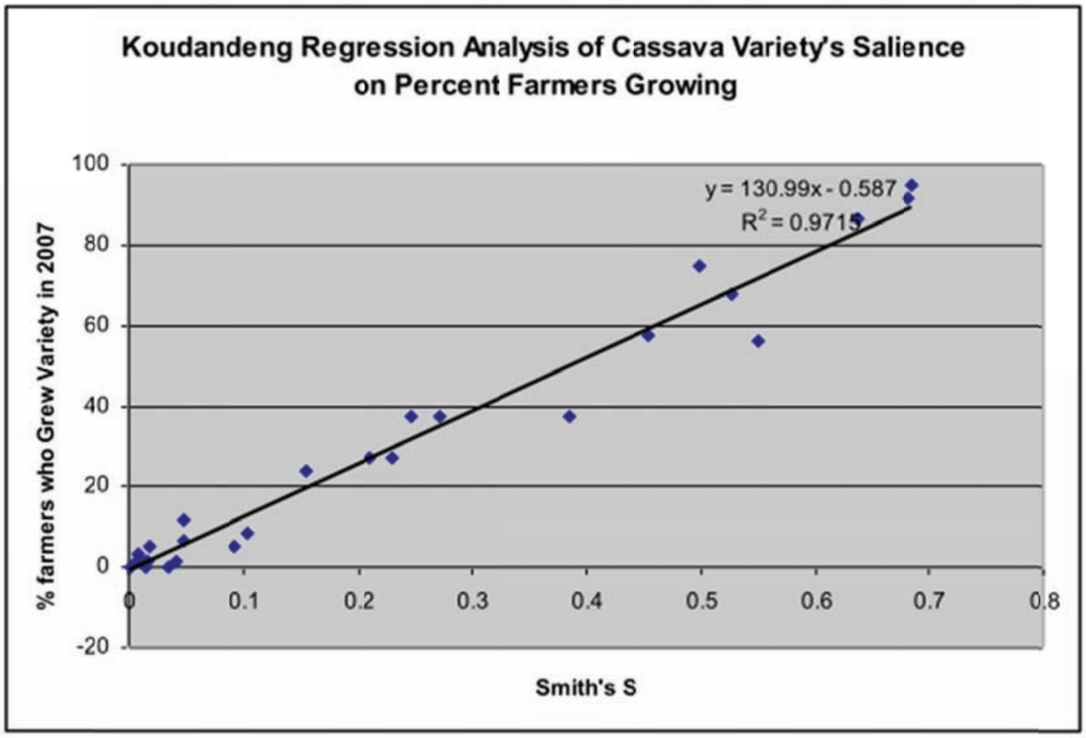
Table 5.18 Percent of Farmers Growing each Cassava Variety that was Freelisted in 2007 in Malende

Variety Freelisted	*Freq.*	*Smiths S*	*Farmers Growing as % of Total N = 59 N = 55*
Kumba black stick	55	0.835	83.6
Agric short branching *	48	0.628	54.5
Red skin **	44	0.378	80
Agric tall branching *	26	0.271	30.9
Kumba white stick	19	0.206	23.6
Red stick short branching	16	0.136	5.5
Yaounde	6	0.056	1.8
20 eye agric *	3	0.026	1.8
Melong stick	2	0.017	1.8
Majeke stem	3	0.017	3.6
Yabassi	3	0.012	0.0
Black stem Susan	4	0.012	3.6
Black stick Mile 40	2	0.007	3.6
Yellow cassava *	1	0.004	0.0
Old stick **	1	0.003	1.8
Ibo white stick	1	0.002	0%

* = HYV; ** landrace

To further understand the relationship between a variety's salience and the percent of farmers growing it, Pearson's correlation analysis was done for the two villages by sex and household HIV/AIDS status. The results showed that the correlation between varietal salience and the percentage of farmers who grow each variety is statistically significant (p<.001) in the two villages and by household HIV/AIDS status in Koudandeng and sex of the farmer in Malende as well. To determine whether one could predict the percentage of farmers growing a variety from its salience index, varietal salience (salience indexes of each variety) was regressed with the percent of farmers growing each variety by sex and household HIV/AIDS status. The output shows that varietal salience is a significant (F< .001, t<.001) predictor of the percent farmers growing each variety in both villages. It accounts for 97.1% and 93.3% of the variation in the percent of farmers growing each variety in Koudandeng and Malende

Figure 5.10 Koudandeng Regression Analysis of Cassava Variety's Salience on Percent Farmers Growing

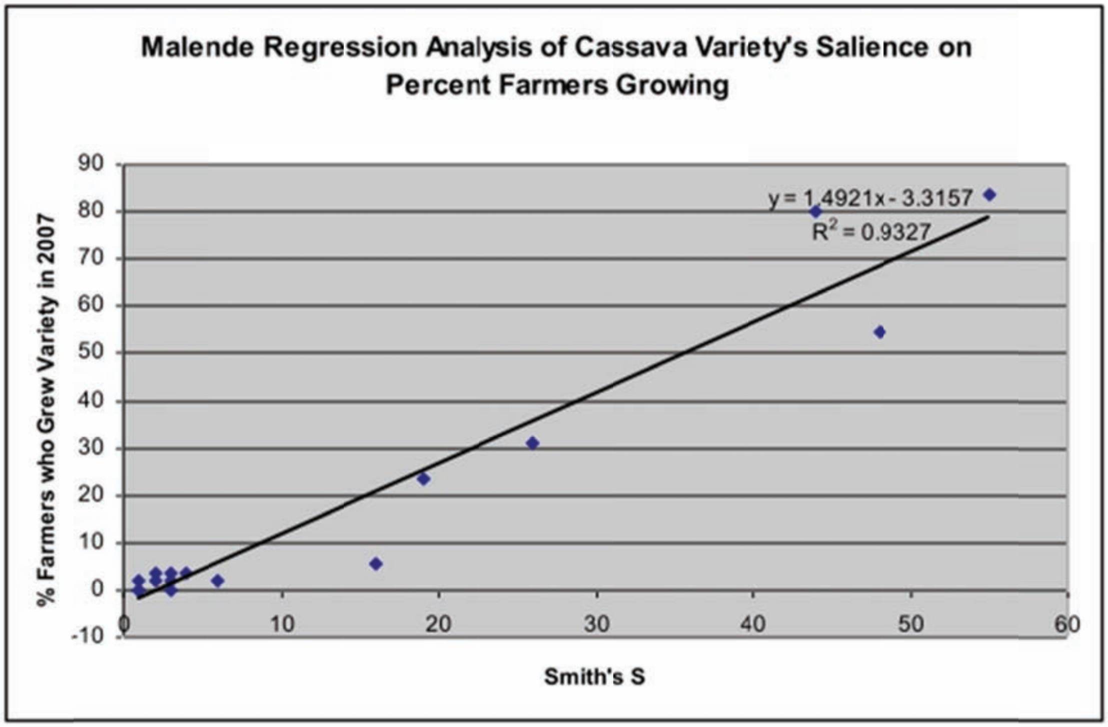


respectively. The results are depicted in figures 5.10 and 5.11.

The variation in the pattern of varieties grown shows that varietal salience significantly predicts the percentage of farmers growing each variety by sex (t<.01, F<.01 for men; t<.001, F<.001 for women) and by household HIV status (t<.001, F<.001 for all categories). It accounts for 90% of the variation in the percentage of farmers from HIV/AIDS afflicted households, 77% of likely afflicted households, and 95% of non-afflicted households growing each variety in Koudandeng. In Malende, it accounts for 45% and 82% in the variation of the percentage of men and women, respectively, who grew each variety in 2007.

The relationship between the way in which farmers cluster their varieties and what they actually grow was analysed by recoding the varieties that farmers grew in 2007 into the clusters to which they pertain according to farmers' classification discussed above.

Figure 5.11 Malende Regression Analysis of Cassava Variety's Salience on Percent Farmers Growing



Arbitrary numbers were attributed to the clusters formed during cluster analysis, and the varieties that farmers grew in 2007 were assigned the numbers of the clusters according to the cluster to which they belonged. To obtain the frequency of the varietal clusters in farmers' fields, the number of times that any variety belonging to a particular cluster was mentioned as grown was counted as a score for that cluster's occurrence in a farmer's field. The total number of times that varieties pertaining to a cluster were mentioned was calculated to represent the frequency of occurrence of that cluster in a farmer's field, and these were then divided by the total number of occurrence of varieties in a farmers' field to obtain the proportion of occurrence of a cluster in a field. The percent occurrence was obtained by multiplying the proportion of occurrence by 100. Table 5.19 represents the results of this analysis.

From the results of the analysis, the frequency of occurrence of the different varietal clusters in farmers' fields in both villages is statistically significant ($p < .001$; $p < .05$). What this means is that farmers in both villages diversify their varietal portfolios by including the range (or at least a diversity) of clusters (groups of similar varieties) in their production systems. However, in this portfolio diversification, not all of the varieties belonging to one cluster are included to the same degree. Some varieties are grown more often than others (tables 5.17 and 5.18). Varietal portfolio diversification differs across farmer sub-groups.

Table 5.19 Frequency of Occurrence of Varietal Clusters in Farmers' Fields

Cluster	*Varieties Per Cluster*	*Freq. Occurrence in Fields*	*Prop. Cluster Occurrence in Fields*	X^2
Koudandeng				
1	Menyo mbandjock Fonctionnaire feuilles verte Fonctionnaire feuilles rouge Ikwemi	188	44%	30.13*
2	Mintole minko Muane Moung	73	17%	43.13**
3	Mbokani Ntangne peau épais Ntangne peau legère Six mois amère Six mois doux Irad [2] Menyo local Manioc jaune[2] Irad local Sanegais Apoba moung	166	39%	38.80*
Malende				
1	Kumba black stick = outlier	46	30%	28.5**
2	Agric short branching[2] Agric tall branching[2]	45	30%	60.0**
3	Red skin Kumba white stick Yaounde Ibo white stick 20 eye agric[2] Majeke Yellow stick[2]	60	40%	33.71**

** = $p < .001$; * = $p < .05$ [2] = research HYV

5.7 Discussion

Breeding and disseminating cassava HYVs raises concerns about cassava diversity and related farmers' knowledge. The main assumptions behind the breeding and dissemination of such HYVs on the part of the Cameroon Government, AGRA, and the CGIAR research institutes is that farmers' local varieties are not high yielding and are highly susceptible to pests and diseases compared to HYVs. Two major issues of concern in relation to this breeding objective that have been analysed in this chapter are:

i. The further dissemination of HYVs may lead to a decline in farmers' knowledge and in the variability of cassava that they manage, and therefore have implications for diversity. It has been argued here that farmers' main objectives are not to increase crop yields, but rather to ensure subsistence and livelihoods and to select varieties in accordance with their particular agroecological conditions, access to inputs, and access to labour. It shows that there are a number of parameters involved in determining farmers' varietal preferences, which influence the maintenance of cassava cultivar diversity.

ii. The implications of the effects of the spread of HIV/AIDS among traditional farming communities for varietal naming, salience, perceptions, and the varieties that afflicted households grow (intra-species diversity) may be significant.

A third issue that has not been amply investigated in this research is:

iii. Despite AGRA's insistence on recognising farmers' local knowledge (especially that of women) in breeding programmes, the fact that no specific methodology exists on how to systematically and effectively capture farmers' knowledge and relate this to their practices (what they grow) or for recognising and dealing with the existence of intra-cultural variation among farmers may lead to the development of cassava varieties that do not meet farmers' needs.

The discussion that follows is organised around the hypotheses that guided the research.

Hypothesis 1

The hypothesis is that the traditional, less ethnically diverse and more subsistence oriented Koudandeng will have more knowledge of cassava varieties relative to the more ethnically diverse and commercially oriented Malende. HYVs will be more salient and widely grown by Malende farmers compared to Koudandeng farmers.

The analysis of farmers' freelist data supported the hypothesis. Farmers in the more ethnically homogenous and subsistence-oriented Koudandeng have acquired greater knowledge of cassava varieties, listing 28 varieties, while more ethnically diverse and commercially oriented Malende farmers have less knowledge, listing a total of 16. The desire to acquire more varieties and therefore greater knowledge may be linked to the fact that, when cassava is a principle staple crop, it has greater significance or meaning for farmers that may be embedded in their culture, foodways, and other cultural values. The relationship between farmers' culture, environment, and crop varieties, where these create the context for specialised uses of such varieties has been emphasised in the literature (Brush, 2004; Hernández, 1972 cited in Brush, 2004; Howard, 2003). It may be that farmers engaging in commercial cassava production focus more on acquiring those varieties that fit their market niches while neglecting their own cultural values, which limits the extent of their knowledge of varieties. It can generally be concluded that, in regions where cassava is the main staple crop, farmers will possess greater knowledge of cassava diversity compared to areas where cassava is not a dietary staple, but rather is grown to supplement household income and diets. Thus, increased commercialisation of cassava does not necessarily increase farmers' knowledge of cassava varieties, but may lead to loss of knowledge since farmers are more focused on the varieties that they sell, which may have implications for diversity maintenance. However, within village variation in farmers' knowledge of cassava varieties exists in spite of their production orientation.

In relation to farmers' knowledge, the fact that cassava varieties have a varied degree of salience among farmers implies that there is *some* amount of agreement (similarity) and disagreement (dissimilarity) among them. Yet farmers do not systematically have different knowledge of the varieties: the variation in farmers' responses is not too great, which is reflected in a high degree of cultural consensus (eigenvalues of the 1st factor to the 2nd factor: 5.97 for Koudandeng, 8.167 for Malende) and agreement (72.5% for Koudandeng, 80.4% for Malende) in varietal lists in both villages. These patterns of similarities and dissimilarities are due to underlying factors, some of which are linked to farmers' social identities (socio-economic and demographic attributes). Intra-cultural variability and differences in knowledge (cultural literacy) among farmers influence the cassava varietal diversity, which is reflected in the variation in the frequencies and numbers of cassava varieties listed. Age, level of education, household headship, and household HIV/AIDS status ($p < .05$ for all these), as well as number of varieties grown ($p<.01$), are statistically significant dimensions for explaining variation in salience and diversity of cassava varieties in the more traditional and subsistence oriented village of Koudandeng. Family size is a statistically weak ($p < .1$) explanation for this variation. Ethnicity (migrant, native) ($p<.001$) and number of varieties grown ($p=.001$) are the only statistically significant explanations for this variation in Malende.

An in-depth analysis of how varietal salience and knowledge vary according to farmers' social identity showed that, in the more traditional, ethnically homogenous and subsistence oriented Koudandeng, varietal salience increases with number of varieties grown, age, family size, and level of education. In relation to household headship, female household heads on average appear to have acquired greater knowledge of varieties, which might be related to their overall greater level of household responsibility as providers of both subsistence and income, and as those who are solely responsible for crop production. On average, there is no difference in the varietal knowledge among farmers in HIV/AIDS afflicted and other household types. However, the existence of intra-cultural variation among farmers accounts for the differences in the salience (meaningfulness) of the varietal types across these farmer sub-groups. For example, the two HYVs are salient only among farmers with either primary or secondary school education or higher, and are not salient among farmers who never attended school. Landraces are more salient among elderly and middle-aged women compared with young women, presumably because the former have had greater experience with, and thus have greater preference for, the landraces.

In the more ethnically diverse and commercially oriented Malende, salience and therefore knowledge increases with the number of varieties grown, but this varies by ethnicity. The average number of varieties known ranged from 2.7 to five among the ten ethnic groups involved. Ethnicity accounts for 20% of the variation in the salience of the varieties by ethnic group. However, what can be noted is that Kumba black stick and Red skin, which are local varieties, are highly salient among all ten groups, and Agric short branching, which is a research HYV, is highly salient among seven out of the ten ethnic groups.

In relation to cassava diversity maintenance, analysis shows that, in spite of farmers' production orientation and ethnicity, varietal knowledge generally increases with the number of varieties managed in both villages. What this means is that, the more varieties that one grows, the more the tendency to know many varieties. What differs is the variation in the varieties known and grown, which is more related to the meaningfulness that each variety holds and the existence of intra-cultural variation among farmers, which determines their preference for specific varieties. The results of the PROFIT regression analysis showed that the number of varieties grown is a significant ($p < 0.01$ for Koudandeng, $p = 0.001$ for Malende) explanation and accounts for 18.3% and 33.1% of the variation in naming the varieties on farmers' freelists in Koudandeng and Malende, respectively. With respect to what farmers actually grow, Koudandeng farmers grow 89.3% of the 28 varieties listed and thus manage greater varietal diversity compared to Malende farmers, who grow 81.1% of the 16 varieties listed. On the aggregate, analysis shows a statistically significant correlation ($p<.001$) between varietal salience and what farmers actually grow in both villages. As well, a regression analysis of varietal salience on the percentage of farmers growing each variety was statistically significant ($F< .001$; $t<.001$) for both villages. Despite this, there is still variation in the percentage of farmers growing each variety compared to each variety's salience index. Ultimately, even though varieties are highly salient among farmers, this does not imply that they are widely grown across all farmer sub-groups. A variety may not be very salient either because it is new or it has greater meaning only for a particular sub-group of farmers or individuals and so is grown only by this group. This is accounted for by the existence of intra-cultural variation among farmers.

The meaningfulness of a variety determines its level of salience among farmers. The HYVs are less meaningful to farmers compared with local varieties (traditional and newly introduced landraces), especially in the more subsistence-oriented Koudandeng. Of the 13 HYVs that were released in Cameroon from 1986 to 2002, only four (30.7%) were mentioned in farmers' freelists. Less than one per cent and 25% of the varieties listed in Koudandeng and Malende, respectively, are HYVs. Thus, HYVs have greater salience in Malende compared with Koudandeng. However, the salience of the varieties varied according to farmers' production orientation. The two HYVs mentioned in Koudandeng are not among the most salient but instead featured among the 10 least salient of the 28 varieties listed, whereas two out of the four research HYVs mentioned in Malende feature among the six most salient. Of the two research HYVs that are less salient in Malende, only one woman mentioned Yellow stick. Previous research in Malende in 1997 showed that over 20% of farmers knew this variety although they did not grow it (Nchang Ntumngia, 1997). The fact that this variety had gained no ground by 2007 indicates the level of rejection among farmers. The variety called 20 eye agric seems to have been recently introduced by IITA and disseminated by the National Root and Tuber Market Oriented Programme (PNDRT is its French acronym), but it was mentioned by only two men and one woman, where the woman who mentioned it is the wife of one of these two men. While accepting the hypothesis that local varieties are more salient and HYVs are less salient in the more traditional and subsistence oriented Koudandeng compared to more ethnically diverse and commercially oriented Malende, the results show that, nevertheless, only a few (about 25%) of the research HYVs are salient in Malende. While the HYVs are among the least salient varieties for all of the farmer sub-groups in Koudandeng, one HYV is highly salient among farmers in seven out of the ten ethnic groups in Malende. It appears that, in spite of the potentially greater exposure of more educated Koudandeng farmers to HYVs (which also permits them to differentiate between these varieties' attributes) they continue to consider older landraces as highly meaningful. Non-educated farmers in this village are the least likely to be exposed to such varieties. Thus, knowledge of the HYVs as measured by salience depends more on the level of farmers' exposure to research and extension rather than on production orientation. As discussed in Chapter 2, Malende farmers have greater exposure to research and extension compared with Koudandeng farmers.

Referring to the diversity of HYVs versus local varieties in the two villages, in the more subsistence oriented Koudandeng, less than two percent of farmers grew both local and at least one research HYV, whereas all 59 farmers grew local varieties in 2007. Of the two HYVs listed, only one farmer grew a variety called Irad, whereas the yellow variety was not grown. In the more ethnically diverse and commercially oriented Malende, all farmers grew local varieties in varying proportions, whereas 55% grew at least one of the four HYVs. Of these four HYVs, only three were grown in 2007, with 55% of farmers growing the variety called Agric short branching, 31% growing Agric tall branching, and two percent growing 20 eye agric. No farmer grew Yellow stick. According to Koudandeng farmers' description of the characteristics of the HYV called Irad, it is likely that it is the same as that which is called Agric short branching in Malende. In conformity with the fact that varietal salience determines diversity, the regression results relating varietal salience with percent farmers growing the HYVs in Malende proved significant (t=.014, F=.014), where varietal salience accounts for 98% of the percent farmers growing them.

It can be concluded that, of the 13 varieties that were released to farmers by research institutions between 1986 and 2002, only two are grown to any degree in the more commercially oriented village, while in Koudandeng, where cassava is the main staple, these varieties are not grown. The varietal attributes that confer meaning determine the acceptability among farmers of HYVs and local varieties. The HYVs that meet farmers' needs are accepted in Malende, but they do not meet farmers' needs in Koudandeng and are rejected. HYVs are more salient and widely grown in Malende relative to Koudandeng, however, HYVs are not fully accepted by farmers even when cassava production is aimed mainly at the market. The low acceptability of HYVs compared to local varieties has been amply discussed in the literature (Lacy et al., 2006; Brush, 2004; Edmeades et al., 2008; Howard, 2003; Sall et al., 2000; Nchang Ntumngia, 1997, 2007).

Hypothesis 2

The values that farmers attribute to cassava in relation to their livelihood options (labour, land, income, subsistence), as well as cultural values (culinary, religious and ritualistic, status) determine the diversity of cassava varieties grown across different socio-economic subgroups of farmers in both the traditional and the more commercially oriented villages under study. HYVs may not reflect these values and therefore the management of HYVs alone may not be an option for farmers relative to their local varieties.

The fact that distribution patterns exist in varietal naming and salience where some cassava varieties are highly salient compared to others, and that distribution patterns also exist in the percentage of farmers growing each cassava variety in both villages, implies that these farmers perceive these varieties differently. This issue is addressed in relation to the perceived proximities (similarities and dissimilarities) among varieties and their classification, to the varietal attributes (characteristics) that are the most salient to farmers, and to how this differs according to production orientation. Analysis showed that, irrespective of production orientation, farmers order or cluster specific varieties together in distinct clusters. According to farmers' classification systems, varieties that are either less salient or are newly introduced (and thus not known by many farmers) are lumped into the same cluster, forming large clusters. Those varieties with which farmers have greater experience and that thus have greater meaning for them are often placed in smaller distinct clusters or are isolated as outliers. The values that farmers attribute to each variety determines the cluster into which a variety is placed, so clusters are formed such that, if a cassava variety has one of the attributes, it is also most likely to have other attributes in the cluster.

On aggregate, the results of the Property Fitting (PROFIT) regression of varietal clusters on varietal attributes show that high palatability, and seed exchange and labour saving/investment are statistically significant attributes ($p < .05$) that explain the variation and delimitation of the clusters in more traditional Koudandeng, whereas average yield is a weak statistical determinant. In the more commercially oriented Malende, in contrast, low or non-susceptibility to root rot disease, late maturation and long underground storage, good processing qualities, and high palatability ($p \leq .05$; $p < .01$) significantly determine varietal clustering, while heritage and phenotype or morphology are significantly weak determinants. These significant attributes could be grouped under the categories agroecological, food security, foodways, livelihoods, seed exchange, labour saving or investment, and culture.

Other studies have shown that farmers often evaluate their crop varieties according to processing qualities, culinary qualities and traditions, and pest and disease tolerance (Zimmerer, 1996; Brush, 2004; Lacy et al., 2006; Abay et al., 2008); suitability for making specific products and or forms of products (Nchang Ntumngia, 2006, Lope-Alzina, 2006, Edmeades et al., 2007; Zannou et al., 2007); yield, early maturation, long underground storability, palatability (taste/flavour, texture and mealiness) (Sall et al., 2000; Lope-Alzina 2007, Nchang Ntumngia, 2006; Lacy et al., 2006; Gibson et al., 2008); local, sweet, newly introduced and association with the names of the state or NGO institutions that introduced the variety (Kisito et al., 2006); and resistance to biotic (pests and diseases) and abiotic stress (drought, soil conditions) (Lacy et al., 2006). Zannou et al. (2007) noted that food culture, income needs and socio-cultural needs and rituals are the major determinants of the diversity of yams among male and female farmers in the transitional Guinea-Sudan zone of Benin. Brush (2004) highlighted the fact that specific wheat landraces are grown by Anatolian farmers in Turkey to produce their traditional dish *asuré* - a sweet mixture of wheat and fruits served during holidays. In Mexico, specific maize landraces are selected and preserved for use in soups (pozoles) and for flour for *tortillas*. Lacy et al. (2006) argue that, contrary to the neoclassical economic models that a risk neutral farmer will grow only that variety that gives the highest profit per unit area, many small farmers in marginal areas are risk averse and so grow two or more sorghum varieties.

Farmers' classification systems are more nuanced than scientific or crop breeders' classification systems, which place more emphasis on agroecological or agronomic aspects. Breeders' varietal evaluation criteria that orient their selection and breeding strategies not only emphasise yield, but also pest and disease susceptibility (IITA, 2007; Ngeve, 2003; Kawana, 2003; IRAD, 1982, 1983, 1989; CNRCIP, 1982, 1983, 1984, 1985), especially those pests and diseases that are considered to be of economic importance such as the cassava mosaic virus and cassava bacterial blight (Ngeve et al., 2006; IRAD, 2004; Hillocks and Wydra, 2002; CNRCIP, 1982, 1983, 1984, 1985). Farmers' classification is based on morphological, functional, spiritual, and cultural (i.e. heritage) criteria. Boster and Johnson (1989), when addressing the debate mentioned earlier on formal or functional classification of organisms among ethnobiologists, noted that a combination of motives determine the ways in which humans interact with their environment. They argue that, on the basis of the existence of patterned intra-cultural variation in judging similarities among organisms, morphology guides novices' judge of similarities among fish, and thus comes closer to scientific classification systems, compared to the expert fishermen of the Southeastern United States whose morphological and functional classification of fish is closer to the utilitarian principle. In agreement with Boster and Johnson's (1989) idea, it can be noted that varietal classification and the attributes that order this classification in farmers' minds varies across socio-economic subgroups. For example, in the more subsistence oriented Koudandeng, the sweet-bitter dichotomy seems to order varietal classification among young farmers who generally do not process cassava, whereas middle aged and elderly farmers go beyond this dichotomy to include a dichotomy between older and new landraces in their classification system. Elderly farmers also perceive varieties in terms of their spiritual value where the belief that associates low crop yield with the negative effects of witchcraft has led to greater use of the varieties called fonctionnaire and demand for Apoba moung – a landrace that no longer exists in this village. In relation to the sweet-bitter dichotomy, all women prefer sweet varieties not only because they save labour (processing time), but also because of their intrinsic medicinal value, where the general belief is that if cassava is eaten raw, it improves male fertility. Also, sweet varieties are eaten raw while farmers work in the fields. The usual practice is for farmers to carry along cooked food to the fields but, as women explained, their heavy workload during peak farming activities limits the time for food preparation in the early morning.

Non-educated farmers in Koudandeng who have probably been less exposed to HYVs cluster them in a distinct cluster whereas the presumable greater exposure of more educated farmers to HYVs leads them to differentiate among them. Women household heads and those in dual headed households agree in their varietal classification with respect to seed exchange (giving of seed as gifts) to maintain kin and friendship ties and with respect to varieties that are labour saving, but differ in their judgment with regard to culinary related criteria, where palatability and marketability are significant criteria for women in dual headed households, and processing qualities are significant for female household heads. Palatability and processing qualities are interrelated in terms of root quality (cooking time, fibre content) and taste (good to boil and eat). These two are also closely related to marketing qualities, not only with respect to root quality and taste, but also in relation to attractiveness and volume of processed products and with respect to fresh tuber qualities. Malende farmers also talked of the weight of the processed product (gari and water fufu) as an important processing quality where varieties that produce lightweight products are not preferred.

Women with small size households view tolerance to root rot disease as an important varietal classification criterion. On the other hand, medium and large households that have high food demand, high labour demand, and that thus seek to avoid the risk of crop failure and ensure year round availability of cassava, cluster varieties towards maturation age, underground storability and the avoidance of varieties that require high labour inputs in crop management. In Malende, women select varieties that have thick canopies and thus shade weeds in their fields as well as varieties that are good for processing into gari. Even though gari processing requires high labour input, its consumption lightens women's work when preparing daily meals. Dry gari is either consumed as a snack or as a meal: "When there is gari in the house, I have no problem because my children soak it and eat in the afternoon after returning from school. This keeps them going until I come home to prepare the evening meal." "We usually take gari along to the fields to quench our hunger and thirst." This explains why Kumba black stick is highly salient and is grown by both men and women in Malende.

The implications of labour requirements for farmers' preferences and management of varietal diversity has been amply emphasised in the literature. For instance, female Rwandan farmers select and manage beans in relation to cooking time (Shellie, 1990 cited in Howard, 2003); the relationship between varietal adaptability (how varieties fit into local resources and context) and households' management of labour leads farmers to manage crop varieties with different growth cycles and tolerance to poorly timed weeding, irrigation and fertilisation (Brush, 2004); the need to optimise labour output influences Southern Malawian farmers' choice of sorghum varieties (Lacy et al., 2006); effective labour scheduling leads Iban Sarawak farmers to manage 15 rice varieties (Freeman, 1970, cited in Brush, 2004); and the loss of native potato and maize cultivars in Andean households is largely attributed to a shortage of male labour (Zimmerer, 1996).

In relation to what farmers actually grow, analysis shows a statistically significant ($p < .001$; $p < .05$) frequency in the occurrence of the different varietal clusters in farmers' fields in both villages. Farmers in both villages diversify their varietal portfolios by including the range (or at least a diversity) of clusters (groups of similar varieties) in their production systems. However, portfolio diversification varies across farmer sub-groups, and not all of the varieties belonging to one cluster are included to the same degree. This diversification is determined by farmers' diverse livelihood options and cultural values that are related to their social identities which influence the attribution of values to specific cassava varieties.

Referring to the issue of whether HYVs meet farmers' varietal classification values, it has been shown that, apart from having low salience among farmers in more subsistence oriented Koudandeng, farmers also often lump the two research HYVs together into the cluster of varieties that have less salience for farmers. In Malende, the two most salient HYVs are sometimes clustered distinctly. According to farmers' perceptions, the most common positive varietal values include high yields/average, high palatability and good processing qualities and suitability for processing (produces soft smooth baton and couscous, produces shiny gari when processed), readily available, early maturing, and high income for those who grow it. Their negative values include: high susceptibility to the root rot disease, which requires early harvest, low yields after three successive plantings, poor processing qualities, short underground storage, and low income, especially in Koudandeng. Poor processing qualities include high water and low dry matter content, and thus reduced volume of processed products, as well as the lightweight of processed products that therefore do not fill the stomach when eaten. These values influence farmers' preferences for local varieties compared to HYVs.

As indicated earlier, in farmers' portfolio diversification strategies on what to grow, varietal attributes determine the choice and frequency of occurrence of each variety belonging to specific clusters on farmers' fields. Except for Malende, where one HYV is grown by more than 50% of the farmers, HYVs are rarely selected relative to farmers' local varieties. The few HYVs that meet farmers' interests and priorities are accepted alongside their local varieties.

Hypothesis 3

Yield and income earning may be greater determinants of diversity among more commercially oriented Malende farmers compared to more subsistence oriented Koudandeng farmers, who may be more concerned with ensuring food security and maintaining their culinary traditions. Local varieties that meet farmers' food security needs and foodways will be more salient and the HYVs (which are bred for high yields and disease tolerance only) will be less salient among Koudandeng farmers compared to Malende farmers.

Following the discussions of hypotheses 1 and 2 above, the findings do not support this hypothesis. Yield is not as significant as other varietal attributes such as root rot, palatability and processing qualities in Malende where cassava is more highly commercialised compared to Koudandeng. Farmers in both villages differentiate between high, average, and low yielding varieties, which reveals a continuum that is contrary to the scientific classification of varieties as either high or low yielding. In spite of farmers' production orientation, ensuring food security and year round availability of cassava, and meeting culinary traditions, income earning, avoidance of high labour input and reducing cassava root rot are farmers' main concerns. Farmers perceive some local varieties to be higher yielding than those HYVs that produce low yields after three successive planting seasons.

Hypothesis 4

As cassava is increasingly commercialised, men will know and grow mainly HYVs, whereas women's knowledge and cultivation of diverse varieties will be greater. The salience of local varieties will be greater among women compared to men.

The hypothesis is rejected, given the freelist data. Sex is not statistically significant in explaining varietal salience and knowledge in Malende or Koudandeng. The average number of varieties known does not differ by sex in Malende. The degree of salience of HYVs is similar for both men and women in both villages. Men and women alike know the research HYVs and the local varieties in both villages. However, in relation to farmers' perceptions of HYVs in Malende, men cluster the highly salient HYVs together with kumba black stick (a local variety), whereas women consider that only the most salient HYV is dissimilar to the other three. Early maturity, no underground storage and palatability are significant varietal clustering variables for men, while phenotype, susceptibility to root rot disease, yield, ensuring family nutrition, processing and suitability for making specific products (especially gari, water fufu, pounded fufu) are significant dimensions along which women classify varieties. These are attributes that facilitate women's achievement of their multiple functions as producers, main processors, and marketers of cassava and ensurers of family nutrition. Likewise, Chiwona-Karltun (2001) argued that female farmers' knowledge of cassava processing techniques is a decisive factor in the diffusion and preference for the bitter cassava cultivars that produce better quality *kondowole* - a staple food in northern Malawi.

As regards the varieties that are effectively grown in Malende, apart for Black stick, which is mostly grown by women (81% of women compared to 19% of men), the difference in the percentage of male and female farmers growing each variety is not significant. Despite this, more women grow the local varieties relative to the HYVs that are grown more by men. As discussed above, the local varieties have more meaningful attributes that respond to women's needs and interests as the main producers, processors and vendors. The local varieties are late maturing and are not preferred by men whose concern is to have rapid turnover. HYVs meet this criterion. Even though the HYVs are perceived to be high yielding, both men and women consider that Black stick produces higher yields than the most high-yielding HYV called Agric short branching. Men and women grow 11 varieties each.

In traditional and subsistence oriented Koudandeng, where cassava is the main staple, cassava is almost exclusively a women's crop because it is believed that it was given to women by the fertility sprits. Also, in relation to the traditional forms in which status was gained in Koudandeng, farming was considered a low status profession relative to wrestling and hunting through which men portrayed their braveness, power, and ability to protect their clan or tribe during intertribal wars. Traditionally, within the farming profession, men's crops are those that require braveness such as climbing the palm tree to tap palm wine or harvest nuts, that imply securing ownership over land through tree and perennial crops, or earning high lump sum income such as coffee and cocoa. These were ascribed higher status compared to women's crops, which were mainly for subsistence with surpluses sold. The two HYVs that were listed in this village are less salient for women and the two male cassava producers in the village. These men knew 54% of the total number of varieties listed in the village. Except for one variety, those that men knew are sweet and do not require processing. This may be related to the medicinal value of cassava where it is believed that, if eaten raw, cassava improves male fertility. The following responses in relation to why sweet varieties are more frequently mentioned than bitter ones further confirm this perspective: "In this village, raw cassava is eaten as treatment for male impotency and so we grow more sweet cassava. This fact is established and every woman knows that she has to make her husband fit for her sexual satisfaction" explained Gertrude. "Some unmarried men are obliged to grow sweet cassava varieties not only as food but also to improve their fertility. An impotent man is just like a lazy woman who lives in famine and therefore has no value," explained Emilienne.

Hypothesis 5

The devastating effects of HIV/AIDS on rural livelihoods may not necessarily have negative implications for intra-species diversity and intra-generational knowledge of cassava varieties and therefore cassava genetic diversity, at least until such effects become widespread or over the long-term.

This hypothesis is supported by the freelist data. The HIV/AIDS status of farmers' households is not statistically significant in determining the salience and knowledge of cassava varieties among commercial cassava farmers in Malende, whereas it is statistically significant in explaining the variation in salience, but not in explaining the number of varieties known among subsistence oriented farmers in Koudandeng. There is no great difference in the number of varieties listed by farmers in HIV/AIDS afflicted (82% of varieties listed) and non-afflicted households (89% of varieties listed). The two HYVs are less salient among these two categories of farmers. It appears that the HIV/AIDS pandemic has not yet negatively affected farmer varietal knowledge, but it would be expected that such an effect would appear only after the pandemic has either affected a larger number of households or an entire generation within households. Fagbemissi and Price (2009), in their study of maize crop pest naming ability among Adja farmers in Benin, found that the HIV/AIDS pandemic does not lead to a loss of knowledge since individuals living with HIV/AIDS have a better ability to name maize crop pests compared to other respondents. They also stated that HIV-AIDS orphans had higher Cultural Consensus Index (CSI) scores relative to all other respondents for a majority of the items measured. Akrofi et al. (2008) found that HIV/AIDS afflicted farmers from female headed households in the Eastern Region of Ghana cultivated more crop species in their home gardens and fields compared to non-HIV/AIDS afflicted households.

In relation to the varieties actually grown, there is generally no significant difference in the percentage of farmers in the different sub-categories of households growing each variety. Farmers from afflicted and non-afflicted households grow 19 varieties each while those in likely afflicted households grow 18 varieties. Apart from one variety (Mintole minko), all varieties that are grown by farmers in afflicted and likely afflicted households are sweet and are mostly early maturing. These are mostly landraces and a few newly introduced varieties. Farmers in non-afflicted households grow both sweet and bitter varieties. While the HIV/AIDS pandemic has not negatively affected farmers' knowledge of the varieties, it seems that it may affect their preference for sweet varieties (which are less labour demanding), which may have implications for varietal diversity in the long run.

5.7 Conclusion

It can be concluded that, of the 13 HYVs that were released to farmers by research institutions between 1986 and 2002, only two are grown in the more commercially oriented Malende, while in Koudandeng, where cassava is the main staple, these varieties are not grown. The varietal attributes that confer meaning determine the acceptability among farmers of HYVs and local varieties. The HYVs that meet farmers' needs are accepted in Malende, but they do not meet farmers' needs in Koudandeng and so are rejected. *In general terms, farmers do not fully accept the HYVs even when cassava is increasingly commercialised, markets are easily accessible, and agroecological conditions for production are very good.* As will be seen in Chapter 6, farmers must develop strategies to effectively incorporate the HYVs to overcome their negative characteristics.

The level of salience of each variety signifies its meaningfulness (which is determined at least in part by their usefulness) for farmers. Farmers cluster (classify) their varieties based on the level of meaningful attributes that determine the choice of which variety to grow. This classification which is based on morphological, functional, spiritual and cultural (heritage) criteria makes local varietal classification systems more nuanced than scientific or crop breeders' classification systems, which give more emphasis to agroecological or agronomic aspects. In their minds, farmers group order their varieties to form clusters such that, if a cassava variety has one of the attributes, it is also most likely to have other attributes in the cluster. The frequency of occurrence of each variety or varietal cluster in farmers' fields is based on their strategies for diversification of their varietal portfolios in their production systems. This diversification, which is determined by farmers' diverse livelihood options and cultural values, varies across farmer sub-groups, and not all of the varieties belonging to one cluster are included to the same degree.

Except for Malende, where one HYV is grown by at least 50% of the farmers, HYVs are rarely adopted. HYVs do not have the market value or level of meaningfulness or usefulness compared to local varieties. Contrary to the assumption behind the promotion of HYVs that local varieties are low yielding and that, therefore, managing HYVs will increase production and productivity, it can be concluded that, even though yield may be important, it is not a major determinant of farmers' preference for varieties compared to ensuring food security and year round availability of cassava, meeting food preferences, earning income, avoiding high labour input and reducing cassava root rot that are farmers' main concerns in the study areas. Moreover, some local varieties are perceived to be higher yielding than the HYVs.

Sex is not statistically significant in explaining varietal salience and knowledge in Malende or Koudandeng and the degree of salience of HYVs is similar for both men and women in the two villages. However, in Malende where men and women grow cassava, the difference lies in their perceptions of the varieties. Men base their evaluation criteria in terms of food security (early maturity, no underground storage) and palatability and seem to cluster the highly salient HYVs together with the most salient local variety. Women base their judgements of the different varieties on the attributes that facilitate the achievement of their multiple functions as producers, main processors, and marketers of cassava and ensurers of family nutrition. As such, their varietal classification systems take into consideration agroecological, food security, culinary qualities, food and foodways and income. This influences their choice of which variety to grow. Even though there is no significant difference in the varieties grown by men and women in Malende, women seem to grow more the local varieties whereas men grow more the HYVs. Men are more concerned with having a rapid turn over and therefore have a preference for early maturing and no underground storage varieties and the HYVs meet these criteria. In Koudandeng where cassava is the main staple and therefore a women's crop, the two HYVs that were listed are less salient for women and the two male cassava producers in the village. The salient varieties among men are sweet and do not require processing, and can either be eaten raw or boiled. It is commonly believed that if eaten raw, cassava improves male fertility.

It appears that the HIV/AIDS pandemic has not yet negatively affected farmer varietal knowledge, but it would be expected that such an effect would appear only after the pandemic has either affected a larger number of households or an entire generation within households.

CHAPTER SIX
TRADITIONAL PRODUCTION SYSTEMS, FOOD SECURITY, AND LIVELIHOODS: IMPLICATIONS FOR A 'GREEN REVOLUTION'

6.1 Introduction

This chapter focuses on the relationship between traditional farming systems, cassava production, food security, food and foodways, biodiversity, dietary diversity and nutrition, livelihoods, and the goals of traditional farm households of Koudandeng and Malende. It addresses the threats posed by widespread diffusion of HYVs and modern intensification of agriculture. It specifically questions whether food security for Africa can be achieved solely by focusing on food availability in terms of volume and stability of production, while neglecting the multiple reasons for which food is grown, using the case of cassava producing farm households in Malende and Koudandeng. First, I examine some of the assumptions made by the Alliance for a Green Revolution in Africa (AGRA), which are also implied in the thinking behind the promotion of HYVs by the Government of Cameroon and in other crop research and development efforts oriented toward cassava. The hypotheses that are examined in this chapter with respect to these assumptions are presented, and the methodology used for data collection and analysis is briefly discussed.

The first results section discusses the multiple reasons for which traditional cassava-based polyculture systems and how this influences their characteristics and management, using the example of Koudandeng. Here, it is argued that traditional cassava polyculture systems not only meet farm households' food security and income needs, but also meet a much more complex set of needs and interests.

The second results section discusses traditional foodways, household food and nutrition security, polyculture crop production, and cassava cultivar diversity. Here it is argued that Koudandeng and Malende households do not face problems of food insecurity, and that it is their own food preferences and those of other local populations that determine which crops are grown and consumed or sold in local markets. Farmers' strategies for ensuring household food and nutrition security as well as for generating income are determined by local foodways, which in turn influence farming systems and crop diversity. Farmers from Koudandeng and Malende grow most of the food that their households need in their traditional intercropped fields and sell their surpluses to purchase the high protein foods and other food items that they do not produce. Focusing on the clear link between agrobiodiversity, dietary diversity, and nutritional diversity and security, this section argues that the simplification of production systems implied by the mass dissemination of HYVS and the promotion of monoculture will lead to a reduction in the number of crop species and varieties and concomitantly in the dietary diversity that can be obtained from one field, which will have negative implications for nutrition diversity and security.

The third results section discusses the relationship between household income, sales of agricultural produce (with a focus on cassava) and household food security. It specifically examines and contrasts AGRA's and the Cameroon Government's aim of reducing the cost of food for all and of providing increased access to credit and incentives to invest in inputs such as HYVs and fertilisers, with the different livelihood options that households chose and the likely resulting competition for investments. It compares the overall income obtained from local cassava varieties versus HYVs, which generally do not meet consumers' food preferences, and examines the implications of a wide scale acceptance of HYVs for household income, livelihoods, and food security and autonomy.

The chapter concludes by revisiting the sub-hypotheses that were developed to analyse the different aspects entailed in the release of HYVs and their implications for food security, and concludes that, even though HYVs may be useful, the displacement of local varieties and species may mean that the global impacts on food security and livelihoods may be negative.

6.2 AGRA-related Assumptions and Research Hypotheses

In the promotion of a 'new green revolution' for Africa, AGRA, the Cameroon Government, and other research institutions such as those of the CGIAR system assume that *per capita* food production in Africa is declining, leading to millions of families living with poverty and hunger. A fundamental solution is promoting improved high yielding crop varieties (HYVs), including cassava HYVs. AGRA argues:

> AGRA works to achieve a food secure and prosperous Africa through the promotion of rapid, sustainable agricultural growth based on smallholder farmers. Smallholders—the majority women—produce most of Africa's food, and do so with minimal resources and little government support. AGRA aims to ensure that smallholders have what they need to succeed: good seeds and healthy soils; access to markets, information, financing, storage and transport; and policies that provide them with comprehensive support. Through developing Africa's high-potential breadbasket areas, while also boosting farm productivity across more challenging environments, AGRA works to transform smallholder agriculture into a highly productive, efficient, sustainable and competitive system, and do so while protecting the environment.
>
> Africa has the singular and tragic distinction of being the only place in the world where overall food security and livelihoods are deteriorating. Over the last 15 years, the number of Africans living below the poverty line ($1/day) has increased by 50 percent, and it is estimated that one-third of the continent's population suffers from hunger. In the past five years alone, the number of underweight children in Africa has risen by about 12 percent. A root cause of this entrenched and deepening poverty is the fact that millions of small-scale farmers—the majority of them women working farms smaller than one hectare—cannot grow enough food to sustain their families, their communities, or their countries…
>
> Achieving a Green Revolution for Africa is a multi-layered challenge. At the most fundamental level, it starts with improved crop varieties for larger, more diverse, and

more reliable harvests. Few farmers in sub-Saharan Africa have access to new, improved varieties of local food crops capable of producing abundant harvests in what are often harsh conditions. Closing this seed gap is a challenge given the continent's shortage of agricultural experts, its large diversity of staple crops and huge variety of pests, plant diseases, and other environmental stresses. AGRA programmes are tackling these challenges through projects that bring farmers and scientists together to develop and distribute seeds suitable for local environments while also supporting genetic diversity and farmers' rights to save seeds. AGRA's "Programme for Africa's Seed Systems" (PASS) is funding African-led initiatives that use conventional breeding to develop new varieties of maize, cassava, beans, rice, sorghum, and other crops resistant to diseases and pests. The goal is to develop and release more than 1000 improved crop varieties over the next ten years.

The mission of the Programme for Africa's Seed Systems is to increase income, improve food security and reduce poverty by promoting the development of seed systems that deliver improved crop varieties to small-scale farmers in an efficient, equitable and sustainable manner. In 10 years, we aim to have introduced more than 1,000 new varieties of at least 10 staple crops that increase the productivity of Africa's small-scale farmers and contribute to the alleviation of the hunger and extreme poverty of 30 to 40 million people. This will result in participating small-scale farmers planting improved seeds on 20 to 30 percent of their cultivated lands. PASS is investing $150 million over five years to mount an across-the-board effort to improve the availability and variety of seeds that can produce higher and more stable yields in the often harsh conditions of Sub-Saharan Africa….

Agriculture has a crucial role to play in the livelihoods of a high proportion of Africans — both as a source of food and income — and is an important contributor to overall economic growth and poverty reduction. Improved crop varieties should allow farmers to increase yields for consumption or for sale, reduce exposure to crop failure through improved resistance to local stresses, and lead to reductions in the cost of food for all.

The general hypothesis that guided this research is that**,** in the study area, which is representative of the 'high end' of cassava production in Cameroon, cassava farmers' objectives are to ensure food security and a livelihood. Further, their food production systems actually achieve these objectives, but cassava HYVs cannot meet these objectives and in fact contribute relatively little to these ends.

Sub- Hypotheses

1. Traditional cassava polyculture systems are managed so that the crop combinations and the temporal distribution of crops meet farmers' multiple needs and interests.

2. It is farmers' own food choices and preferences and those of other local populations that determine which crops to grow and sell in local markets. Farmers' strategies for ensuring household food and nutritional security are determined by their local foodways, which in turn influence farming systems and crop diversity.

3. Cassava farmers in Koudandeng and Malende do not confront problems with food security and malnutrition since they grow most of the food that their households need in their traditional intercropped fields.

4. Traditional cassava polycultural systems provide a nutritionally adequate diet.

5. Livelihood strategies and options in Koudandeng and Malende are complex and diverse and, in their pursuit of these strategies and options, households' cash and labour investments are competitive for each livelihood activity. The low acceptability of HYVs among farmers and consumers implies that total income from HYVs may be low, and therefore wider acceptances of HYVs could reduce the earnings that farmers currently generate from cassava sales and thus destabilise livelihoods, especially for women and for those farmers who depend mostly on cassava for income, which in turn will have implications for household food security.

6.3 Methodology

In general, 65 cassava-producing households (30 from Malende, 34 from Koudandeng) were selected for this research using a stratified random sampling procedure (for a full discussion of the sampling procedure used in survey data collection, see Chapter 3). The stratified random sample was selected from the total sample of households that were censused by the researcher in 2003. Given the ethnic diversity of Malende and the varied socioeconomic characteristics of farmers in both villages, which may influence cassava varietal diversity and livelihood strategies, it was necessary to ensure that farmers from various social strata were included if complete knowledge of these domains was to be obtained. HIV/AIDS afflicted households and polygamous, dual headed and single headed households were purposively included in the choice of households. Willingness to participate was an important selection criterion. In the case of dual headed households, couples were interviewed separately to avoid interference and to overcome the fear of revealing information that either men or women considered to be confidential.

Three main methods were used to collect the data: a household survey, in-depth interviews, and a literature review. Participant observation was employed sparingly, especially in relation to processing of different cassava products. A household survey was used to collect data related to households' socioeconomic status and general livelihood activities, total household land holdings, food crop production and sales, and household income. An additional cassava survey enabled the data to be collected related to household income from cassava; reasons for managing cassava-based polyculture fields that orient households' decision making frameworks; cassava production, consumption, and gift giving; households' labour and land constraints; the forms into which cassava is processed and the suitability of each variety for making these products; and the value and price of HYVs and local varieties in different local markets.

In-depth interviews were employed to gain deeper understanding of issues related to traditional foodways, traditional dishes, and their methods of preparation, and to cassava processing and the labour and skills entailed. It was also used to clarify doubts related to the data collected from the two surveys, especially in relation to the value of HYVs versus local varieties in local markets, the food items that households purchase, and gender differentiated labour and land constraints.

The survey data were analysed using proportions, percentages, and frequencies. Tables and graphs were used to summarise and present more specific data. Photographs were also used to illustrate some of the important points made. Qualitative interview data were coded and analysed narratively (description, explanation, interpretation, quotations). Grey and published literature was reviewed to identify the nutritional components of some companion crops that are grown in cassava-based polyculture fields.

6.4 Results

6.4.1 Characteristics of Traditional Cassava Polyculture Systems: Reasons for Managing Cassava-based Polyculture Fields

AGRA is principally concerned with the total volume of food and income that small farmers produce and, to that end, focuses on increasing food production through the use of external agricultural inputs, and on increasing crop commercialisation. Prescriptions are based on a business-oriented model, as the first paragraph of the quotation above clearly suggests: Africa's farming systems should become "highly productive, efficient, sustainable and competitive". AGRA partners imagine that African farmers grow food crops with the sole purpose of providing food and income for their households, and that they seek to be successful and competitive in the marketplace. Here, I argue that traditional cassava polyculture systems meet a much more complex set of needs and interests. Apart from satisfying nutritional and food security needs and earning an income, food crops are grown for a multiplicity of reasons, including to meet social obligations, maintain cultural identity, fulfil spiritual values, manage labour supply, deal with land constraints while maintaining agroecological integrity, and preserve and manage genetic diversity.

6.4.1.1 Orientation of production toward maintenance of crop and varietal diversity

As discussed in chapters 2 and 4, farmers grow a combination of at least six to seven different crops per cassava-based polyculture field. In Chapter 2, it was shown that farmers manage different food crop fields in polyculture, such as plantain-based, cassava-based, cocoyam/colocasia-based, yam-based, groundnut-based, maize-based, egusi-based, and sweet potato-based fields. Each field contains a combination of major and minor crops. For example, a plantain-based field in Koudandeng contains plantain and banana as major crops, and cassava, groundnut, cocoyam, and African plum (*safou* or *Prunus africana*) as minor crops (Table 2.6). A yam field in Malende contains sweet yam and water yam as the major crops and egusi, maize, sweet potato, plantain, cocoyam, and *okongobong* (a green leafy vegetable) as minor crops (Table 2.7). Apart from the crops that are grown, trees and incompletely burned tree stumps, trunks, and branches, and plant debris, constitute part of the myriad of plant materials in a polyculture field. This combination provides the crop and tree diversity that respond to farmers' needs and interests. Furthermore, in Chapter 4, it was shown that cassava-based polyculture fields consist of cassava, egusi, maize, and groundnut as major crops, and yam, pepper, plantain, cocoyam and green leafy vegetables as minor crops in Malende (Table 4.4), whereas in Koudandeng, these fields consist of groundnut, maize, cassava, plantain, cocoyam, and green leafy vegetables as major crops, and okra, egusi, sesame, onion, and tomato as minor crops (Table 4.3). These crops are planted in myriad combinations that reflect not only farmers' agroecological needs, but also the diverse services that these crops render to them (fuelwood, income, labour savings, dietary diversity, food security, and fulfilment of cultural and spiritual values).

While different crop combinations are grown in cassava-based fields, there is also a diversity of varieties of each crop species grown in the same field. For example, in Chapter 4, it was shown that farmers grow on average three to seven cassava varieties in the same field. This combination includes both early and late maturing varieties, local varieties and HYVs (in the case of Malende), sweet and bitter varieties, varieties with varying susceptibility to root rot disease, varieties with different underground storage capacities, high and low income earning varieties, and varieties that have spiritual and health connotations. The discussion in section 5.5 of Chapter 5 on farmers' perceptions of the different cassava varieties that they grow shows that each cassava variety has a specific meaning for farmers. These range from agroecological (yield, pest and disease susceptibility) through to food security (maturation period, underground storability), foodways or food habits (processing qualities, suitability for making specific products, palatability), income and livelihoods values (marketability, labour saving, seed exchange), and heritage and spiritual values. The values attributed to each crop species and variety and the diverse services that farmers expect to obtain, guide farmers' production orientation in their traditional production systems toward preservation of crop diversity and maintenance of traditional management practices. These values and services are intertwined in a web such that any alteration, such as incorporating HYVs, may disrupt this web and have negative implications for farmers' well being and food security.

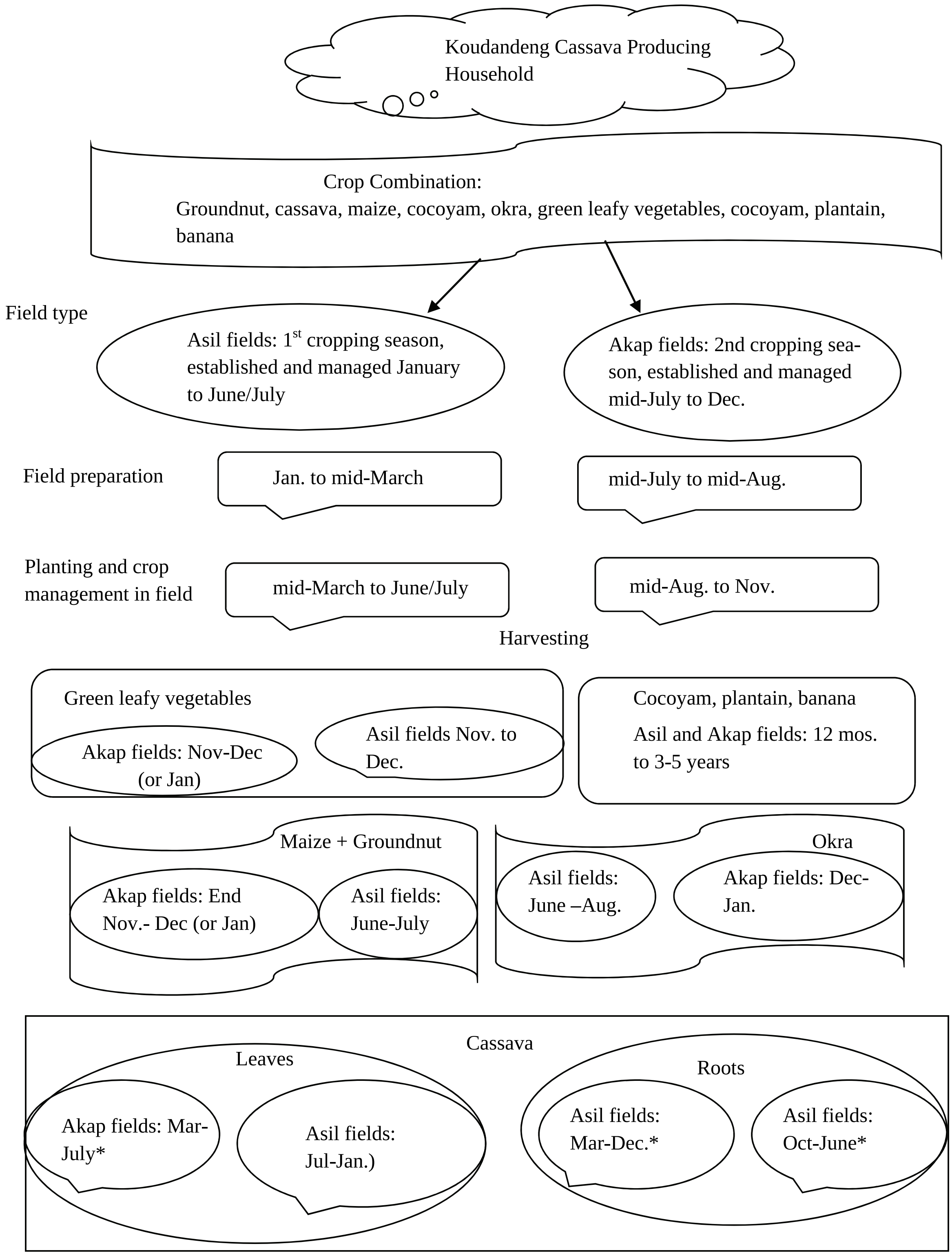
6.4.1.2 Year round harvests and avoidance of risks of crop failure

a) Seasonality of production and harvest

Farmers combine a number of strategies to ensure year round food availability from their own fields, including: planting early and late maturing varieties, planting crops that can be harvested continuously (piecemeal), and planting complementary crops in two cropping seasons. Temporal co-occurrence of crops and crop varieties in the same fields, maturation period, and the potential for piecemeal harvest of crops and crop varieties are the production parameters that farmers consider to ensure year-round food availability for their households, as well as meet traditional foodways (discussed below). For example, in Koudandeng, except for groundnut and maize, all of the other companion crops in a cassava-based polyculture field are harvested piecemeal, which makes food available continuously and spreads labour throughout the year. Figure 6.1 depicts a seasonal calendar that emphasises seasonal crop harvests in a cassava-based polyculture field and the seasonal availability of each crop for a household.

In relation to maturation periods, farmers plant both early and late maturing crops and varieties as companion crops. In Figure 6.1, groundnut, maize, green leafy vegetables, and okra are early maturing crops, and cassava, plantain, banana, and cocoyam are late maturing crops. Even though they are planted at the same time, their maturation periods vary and thus farmers can ensure year-round food availability (early maturing crops and crop varieties are eaten before late maturing varieties are harvested), which allows women to fulfil their responsibilities to provide food for their households.

Figure 6.1 Seasonality of Food Availability from a Cassava Polyculture Field for a Koudandeng Household



Multiple plantings of crops and crop varieties in a single year is another strategy for ensuring year-round food availability. As discussed in Chapter 2, Koudandeng has bimodal rainfall with two cropping seasons: the first from mid-March to June, and the second from mid-August to December. Fields established during the first season are called *asil* fields, while *akap* fields are established during the second cropping season. Groundnut/cassava-based fields are established according to the rainfall regime and cropping season. Unlike some areas where farmers experience a lean season, Koudandeng farmers speak of periods when certain food crops are abundant or scarce, especially in reference to vegetables, groundnuts, and maize. The periods of scarcity often correspond to periods of peak farming activity. For example, harvesting of crops grown during the second cropping season is spread throughout the period when fields that will be cropped during the first season are being prepared and planted and crops are established, and *vice versa*. In this case, piecemeal harvest is very important and therefore the potential for piecemeal harvests represents a major criterion for farmers' choice of crop varieties. Maize and groundnut are not harvested piecemeal, but their harvest coincides with the beginning of the period of peak activity (June-July, December-January) and their produce is eaten throughout this period.

The seasonal calendar of food crop production and harvest shows that, while annual crops are grown yearly, semi-perennial and perennial crop fields are established and managed over a longer period: from three to about five years in the case of plantain, banana and cocoyam, and over 25 years in the case of oil palm and fruit trees. While annual crops and fruits are harvested seasonally (except for cassava and cocoyam, which are harvested piecemeal), the harvest of palm nuts and plantain/banana is spread throughout and across the years. During periods when annual staple crops are scarce, plantain and banana are consumed as staples. By this means, households avoid food and nutritional insecurity.

Annual crop fields are not all established at once during a cropping season. For example, in Koudandeng, observation and discussion with five farmers (one man and four women) showed that yam fields are established in January (dry season); cassava, maize, groundnut, cocoyam, and green leafy and fruit vegetables are sown from mid-March to mid-April; while sweet potato is planted from May to June/July. Households begin by harvesting maize, groundnut, and vegetables between May and July, and yam and sweet potato from August through October/November, while the harvest of some early maturing cassava varieties begins in January of the following year. As such, households never experience hunger, although they may experience periods when specific staple crops are scarce.

The discussions on foodways in Section 6.2 below highlights the fact that households orient their production systems toward providing diverse diets for their households and thus manage different types of food crop fields. The constituents of their traditional diets are made from a combination of diverse crops that are either all grown in the same polyculture field or are grown in various polyculture fields. Achieving complementarity within and between food crop fields to ensure year round availability of such diverse foodstuffs is therefore an important production goal. When a particular field does not provide all of the required ingredients for the traditional diet, another field type will complement it. The discussions on farming systems in Chapter 2 showed that most trees and semi-perennial crop fields (e.g. oil palm and plantain/banana fields) are managed mostly by men, whereas annual food crop fields that produce staple crops are mostly managed by women in Koudandeng and, to a lesser extent, in Malende. Within households, men and women's fields constitute complementary production spaces in relation to household nutrition by providing nutritionally adequate diets. Crops are harvested from both fields for household consumption. In addition, the fruits harvested from men's orchards provide many of the essential nutrients (especially micro-nutrients) that are not provided by staple crops.

Koudandeng's traditional foodways (Section 6.4.2) influence the year round availability of food in that women strive to provide their families with their traditional meals year round. For example, a traditional Koudandeng meal consists of cassava (boiled roots or its products: couscous, baton) that is eaten with a vegetable soup or sauce with groundnut as the soup/sauce thickener. Green leafy vegetables are harvested when cassava leaves (the main vegetable source) are scarce. Dried groundnuts must always be available to be used as a soup/sauce thickener, while cassava must always be available as the main source of energy (carbohydrate).

Not only are different crops planted, but also many varieties are planted that have different growth and maturation cycles. On average, seven cassava varieties are planted in a polyculture field in Koudandeng and three are planted in Malende (see Chapter 4). Farmers plant both early and late maturing varieties to ensure year round availability of cassava: "Early maturing varieties such as Fonctionnaire and Six mois doux save us from hunger;" "I plant both late and early maturing varieties in the same field because we start eating the early maturing varieties (six months after planting) while waiting for long cycle varieties to mature," are some common statements made in Koudandeng. The early maturing varieties are harvested and eaten during periods when later maturing varieties and all other companion crops are not fully established and the yields of the previous harvests are almost exhausted. This keeps farm households from experiencing hunger during such periods.

b) Risk avoidance

Farmers' production strategies are oriented toward risk avoidance. The low incidence of pests and diseases in polyculture fields compared to monoculture fields was discussed in Chapter 4. Other risk factors include uncertain weather conditions and possible soil nutrient depletion (from growing crops in fields that have not recovered sufficient fertility in a fallow period) that may also lead to crop failure. In farmers' logic, combining different crop species and varieties in polyculture reduces the risk of crop failure. If one crop produces low yields due to low tolerance to water stress, pests and diseases, or low nutrient supply, the higher yields of a companion crop that is tolerant of these unfavourable conditions compensates for the low yields obtained, and in this way the household never goes hungry. Different crop species and varieties respond differently to risk factors. Farmers' perceptions of cassava varieties in terms of susceptibility to pests and diseases and degree of tolerance to water stress during the dry season (see Chapter 5) are some of the guiding principles behind the clustering of varieties and therefore behind varietal selection. Farmers mix varieties that are highly susceptible to root rot disease with those that are less susceptible, and those that tolerate low levels of specific nutrients supply in the soil with those that do not, and those that tolerate water stress during the dry season and those that do not. By this means, they are likely to obtain sufficient yields overall and therefore provide food for their families.

6.4.1.3 Orientation of production objectives toward meeting social needs

As discussed in Chapter 3, food crops are not only produced to meet farmers' nutritional or biological needs, but also to fulfil socio-cultural needs. Food constitutes a central part of one's culture and is central to one's sense of identity. Some of the socio-cultural factors that determine Malende and Koudandeng farmers' choice of cassava varieties include: defining and maintaining social relationships; demonstrating and bolstering self-esteem, prestige and social status; remembrance of loved ones; negotiating within families and households; and maintaining wealth, cultural identity, and spiritual and medicinal values and health.

a) Social relationships and farmers' choice of cassava varieties

Cassava is the main staple crop in Koudandeng and is mainly grown by women. Women use cassava varieties, especially the highly valued local varieties, to create and maintain relationships through the exchange of plant material. Creating and maintaining relationships constitutes an element of women's social capital. For example, a woman who shares her cassava plant material with friends in turn receives assistance in the form of labour for her fields when she is ill. A mother-in-law accepts and expresses her love to her daughter-in-law by giving her the most/highly valued local cassava varieties in return for other services (financial, food, labour, household chores) in time of need. Such solidification of women's social networks through plant material exchange has been reported for other societies (e.g. Boster, 1986; Lerch, 1999; Pionetti, 2006).

b) Status and prestige

Self-esteem, prestige, and gaining and maintaining social status are important aspects of farming (see e.g. Nazarea-Sandoval 1995, Boster 1986, Howard, 2003; Heckler 2004). In the study area, traditionally a woman's worth lies in her ability to grow and manage many food crop fields, crop species, and crop varieties. In Koudandeng, a woman who manages many groundnut/cassava-based polyculture fields as well as many cassava varieties gains recognition as a hard worker who can feed her household and her husband's relations. This is the case of Marie (60 years old), who manages 17 different cassava varieties. She is often referred to as one of the most knowledgeable and hardworking women in the area. One male informant said, "If you want to know more about cassava, speak to Mama Marie who lives near the Chief's house. She will tell you all the types of things that you want to know. Many researchers who come to this village talk to her." A discussion with Gertrude (58 years old) and Régine (46 years old) highlighted the fact that they view themselves as respectable women in the village because they grow and process many cassava varieties for household consumption and sale. As such, they are not always in need of financial assistance from their husbands or male friends. Gertrude explains:

> Any woman who does not produce enough cassava in this village is looked low upon and considered a lazy woman by other women and men of the village and is being mocked at. A woman who has many cassava fields has a very high social status because such a woman has pride and does not sit and wait only on her husband for the

> resolution of family financial problems. I do not care much about my husband when I have produced enough cassava in the fields. I sell cassava in time of need and make my financial contributions in my social groups with the income from cassava sales. My husband cannot treat me without respect. On the contrary, our husband is mocking my senior co-wife, who has just lost her thirty-year-old daughter, because she has no cassava in the fields and so is unable to assist her husband financially to pay for the mortuary fee of her late daughter. She just sits and weeps because she has no cassava fields and, moreover, she is naturally lazy and is always very sick. When I do not have groundnut in stock but do have enough cassava, I am happy because I sell my cassava to buy groundnut seed to plant as well as solve many other financial problems that crop up.

In Chapter 5, Section 5.4.2, dealing with vernacular varietal names, it was shown that the cassava variety called Fonctionnaire is named as such because it earns high income and makes women 'rich', which equates them to government civil servant (*fonctionnaire* in French) status. Social status is not only gained by managing many groundnut/cassava-based polyculture fields and cassava varieties, but also by managing varieties that have high market value.

c) Heritage value and emotional significance

Much research has reported that particular varieties are grown because of their heritage value and related emotional significance **(**Nazarea et al., 1997; Sereni Murrieta and Winklerprins, 2003; Howard et al., 2008). Some women use the different cassava varieties that they grow as a means to remember loved ones, both dead and living. The common sayings are, "This variety was grown in the days of our forefathers;" "My grandmother and mother grow these varieties and so I maintain them." Some women explained that they are motivated to manage many groundnut/cassava-based polyculture fields and varieties when they remember their late mothers and loved ones when they are working in their fields. Working hard and preserving most of the varieties that these people grew or grow shows respect for them. Gertrude explained:

> When I am in my cassava fields, I always think of my late mother who worked so hard and managed many cassava varieties. She distilled and sold whisky called *meungwalla* from cassava. Whenever she was caught and detained or fined by the forces of law and order for selling an unauthorised drink, the money obtained from the sale of *meungwalla* released her from detention. Upon her release, she distilled and sold more *meungwalla* to pay her fines with or buy her way out from being pursued again. This fact motivates me to work even harder and to maintain the varieties that she grew. I also distil and sell *meungwalla*.

Andriette reported:

I lost my mother at a very young age and was raised by a woman in the village. This woman manages so many cassava varieties as well as processing and selling baton. I learned this trade from her. Whenever I am working in the field, I always think of her and this motivates me to work harder. I want to be as rich and knowledgeable about cassava varieties as she was.

d) Negotiation within households and families

The different cassava fields and varieties constitute a source of power for women where their ability to manage these gives them influence over their husbands and other relations. A hardworking Koudandeng woman uses this fact to negotiate for more farmland from her husband or his kin in order to establish her groundnut/cassava fields. This negotiation power increases women's motivation to seek and manage many cassava varieties, especially those that are appreciated by their husbands and relations. Women's ability to prepare and serve traditional cassava meals increases their negotiation power with their husbands since it is said that a woman who pleases her husband receives whatever she requests from him. Women thus grow those varieties that are suitable for these traditional dishes.

e) Maintaining cultural identity and spiritual values

Among Yaounde urban and Obala urban-periphery dwellers, Koudandeng has reputation for making good quality baton, a traditional cassava product. This reputation stems from traditional beliefs in Koudandeng, where women are expected to make big, long, and good quality baton in honour of their totem spirit who led them cross the river Sanaga on his back during their migration from Mbam Division. This deity, called *ngomedjap,* was a two-headed snake, and so baton is made in this form as depicted in Figure 6.2. This reputation results in higher value sales and rapid turnover for baton produced in Koudandeng in these markets. Women therefore seek and maintain the local varieties that were grown by their foremothers so as to maintain this standard and earn higher income. As discussed in Chapter 5, these varieties include: Apoba moung, Muane moung, Mintole minko, Mbokani, Mekoughe, Mekoughe congo, Six mois amère, Six mois doux, Ntangne thick tuber peel and Ntangne thin tuber peel.

Figure 6.2 Ndeng (baton) – A Fermented Cassava Paste Wrapped in Leaves as a Symbol of the Ngomedjap Deity

The cultural and social embeddedness of crop varieties that influences farmer's varietal decisions is well established in the literature (Boster, 1984; Wilson, 1987; Heckler, 2004; Uzendoski, 2004; Zannou et al., 2007). In Koudandeng, it is believed that the fertility spirits gave cassava to women. As such, it plays a special role in Koudandeng farmers' belief system, having an essential role in the rites, rituals, and ceremonies of the people of the Esselle clan to which Koudandeng belongs. These rites and rituals are differentiated by sex, based on gender definitions of roles and responsibilities. Women, who are traditionally responsible for procreation and have the obligation to feed and ensure continuity of the family they bear, perform agricultural and fertility rites and rituals (interview with papa Bonaventure, 79 years old and Ayissi, 40 years old). Men, who traditionally are assigned the protective role within families and in the Esselle clan as a whole, perform ancestral and death rites and rituals. The main cassava product eaten during these rites and rituals is baton, or *ndeng* as it is locally called, since it symbolises *ngomedjap*, while *meungwalla* – a locally distilled whisky made from cassava – is an important drink. Varieties that are suitable for making *ndeng* and distilling *meungwalla* are highly valued and are conserved by women.

Crop production, especially cassava production, childbearing, child development, and the success of children, especially of girls, are considered to require the guidance of the gods and spirits of the land. In the Esselle belief system, witches mystically withdraw food (especially cassava) from others' fields to increase their own yields; poor reproductive success (infertility, single sex child bearing), and problems with children (unsuccessful marriages, low success at school and joblessness), especially with girls, are a result of spiritual manipulations provoked by wicked women. These acts displease the gods and spirits of the land whose responsibility is to ensure equity and peace. At the onset of the rains, before crops are sown, agricultural and fertility rites and rituals are organised and performed by four elderly women who are believed to have been endowed with special powers to invoke, communicate with, and appease the spirits and gods of the land to obtain high crop yields, and increase girl-child marriages and children's success in school and in professional trades. Disputes among women are settled and violators are sanctioned and traditional medicine drunk to prevent future malevolent practices. Such rites and rituals are performed at midnight under a tree (*arbre à palable* in French) that is located at the centre of the village where disputes are settled. Baton or *ndeng* is used in such rituals since it symbolises their deity.

Special rites and rituals are performed by these elderly women in the homes of childless couples and couples who bear children of a particular sex only, where merry making and incantations and invocations of the fertility spirits and gods are made. When barrenness is entailed, spiritual *in vitro* implantation of babies is performed using a special species of onion, while in the case of women who children of only one sex, the sex of the child in the womb of the pregnant woman is changed to the desired sex in a ritual known as called *mvi-anglange*.

Ancestral rites and rituals are performed when accidents (road accidents, falling out of a palm tree, drowning in the river) and premature deaths among children and youths are rampant, as well as during famine and at times of frequent illness. The occurrence of famine is associated with misbehaviour, including family disputes and frequent wife-battery (assault), which result in frequent illnesses and low crop and fish yields. In these cases, the ancestral spirits must be appeased. This rite is organised by four men who represent the main families of the Nkolfeppe lineage to which Koudandeng belongs, who the ancestral spirits and god of the land endow with special powers. The god of the Esselle clan is called *Ilopoumebengne* or

Ntondombeu. This rite, which is most often performed at a sacred spot in the river called *samnwolo* and sometimes under a tree called *l'arbre como,* is attended by all male descendants of the Esselle clan who are at least 40 years old. It is believed that there are three fish in *samnwolo* that represent the ancestral spirits: a white fish, a fish with a jewel on its neck, and a fish with a very short caudal fin. During the rites, which last for 24 hours, disputes are settled and rituals are performed and incantations are made to the spirits so that they can hear the plea of the people and intercede with the deity of the land. The rituals and incantations are aimed at driving away evil to the other side of the river (to the spirit world) while receiving the good things on their side of the village (the world of the living). Much fish in the river, high crop yields, fewer illnesses and deaths (especially premature ones) and accidents, and peace within families are some of the rewards that the rites and rituals bring. *Ndeng* (baton), which symbolises their deity, is the only cassava product that is eaten alongside other food items. *Meungwalla* is drunk alongside palm wine and beer.

Traditionally, a man who dies at the age of 70 years and above is said to have achieved much for his family and for the village and he therefore must be buried in a dignified manner. The rites and rituals that are performed are called *esanie*, which entails playing the xylophone or drums (*jouer le tam-tam ou le balaphone* in French). This rite must be organised only by sons after the burial of the deceased, which symbolises their right to inheritance over their sisters. The success of this rite is typified in the level of merriment achieved, so *meungwalla* is a very useful drink, since it serves as a stimulant. *Ndeng* (baton) is also served alongside other cassava products and food items. Organising this ritual is an occasion for invoking and communing with ancestral spirits, discussing pertinent family issues, and meeting out sanctions within closed circles while villagers are dancing and making merry.

While it is believed that the spirits gave cassava as a gift, it is also believed to have special protective powers against spirits and witches/wizards. It is commonly claimed that cassava is 'medicine against evil spirits'. Varieties such as Apoba moung and Fonctionnaire are said to have special protective powers and so are highly valued by women who plant them in their fields to protect them against other women's witchcraft. Some elderly farmers in Koudandeng discussed this belief. Some women also indicated that fresh cassava stems and leaves are cut and placed at the four corners of one's room to protect the resident from spiritual attacks by witches and wizards. The scarcity of the Apoba moung variety means that the Fonctionnaire variety is frequently used for this purpose.

Cassava is also used as a ceremonial food in deaths, births, marriages, and Christian feasts (marriages, baptisms, first communion) and on political occasions. *Ndeng* (baton) in particular plays a major role since it symbolises *ngomedjap*. For example, traditional marriage ceremonies are marked by the presentation of a special delicacy made of thick groundnut porridge tied in a very large bundle of banana leaves and one large long *ndeng*. The sisters and wives of the brothers of the groom prepare this delicacy, which they present to the family of the bride as a sign of her acceptance and assurance of her well-being in her new family. In return, women from the bride's family (sisters, aunts, mother, uncle's wives, cousins) prepare this delicacy, which accompanies the bride to her marital home in appreciation of the goodwill of the in-laws toward their daughter-in-law, and to crown the festivity. Women therefore seek and maintain all of the varieties that are suitable for making *ndeng*.

Apart from the nutritional value of cassava, Koudandeng farmers believe that, if eaten raw, cassava makes the penis erect and enhances male fertility. In the discussions of the results obtained in Chapter 5, of the 28 cassava varieties that are known in Koudandeng, 24 are sweet varieties (low cyanide content). This plethora of sweet varieties is partly due to their ability to enhance male fertility. Gertrude and Emilienne explained: “In this village, raw cassava is eaten as treatment for male impotency and so we grow more sweet cassava. This fact is established and every woman knows that she has to make her husband fit for her sexual satisfaction” (Gertrude); “Some unmarried men are obliged to grow sweet cassava varieties not only as food but also to improve their fertility. An impotent man is just like a lazy woman who lives in famine and therefore has no value” (Emilienne).

Table 5.8 in Chapter 5 also shows that palatability is a significant cassava varietal evaluation criterion for women in dual headed households. Palatability is viewed in terms of fresh root sweetness (low cyanide content), good taste, and the ease with which it can be chewed (low root fibre). While women seek and maintain sweet cassava cultivars, those that have good taste and are easy to chew are highly valued since they can be eaten raw. Raw cassava is eaten as a mid-day snack while working in the fields, which lightens the burden of preparing and carrying food to the fields.

Koudandeng farmers reported that *meungwalla* is used to treat common ailments such as stomach disorders (from eating bad food) and general body pains due to hard work in the fields. For the treatment of stomach disorder among adults, 10cl of *meungwalla* is drunk thrice a day until the patient is better. For the treatment of body pains, *meungwalla* is drunk in varying quantities, depending on the metabolism of each individual. The measure for the drink ranges between 5cl and 10cl. Women who distil *meungwalla* maintain those varieties that are suitable for distilling, especially the local varieties that are perceived to have low water content and good taste.

6.4.1.4 Income earning objectives

Cassava is viewed as an important source of income in Koudandeng and Malende, especially for women. It is sold either fresh or processed into gari, water fufu, kumkum (cassava flour or couscous), makra, or miondo and pounded into fufu in Malende, and ndeng (baton), couscous (*vouvou* in the local language), beigner, and meungwalla in Koudandeng. Discussions with five women (two from Malende, three from Koudandeng) and analysis of the income expenditure items from the cassava survey show that income from cassava is used to pay for children’s education (school fees, books, stationery, uniforms, and shoes), to provide health care for families and household provisions and the food items that women do not produce, to pay for hired labour, to make contributions in social gatherings and to the church, and to secure access to credit. The common saying among women is, “A woman without a cassava field is a living corpse.” Women manage varieties that earn high income, such as Kumba black stick, Kumba white stick, Red skin and Agric short in the case of Malende, and Ikwemi, Fonctionnaire, Mintole minko, Menyo mbandjock, Muane moung, and Ntangne in the case of Koudandeng (see Chapter 5, tables 5.8, 5.15 and 5.16).

Peak processing periods coincide with periods of festivities (Christmas, New Years, Easter) and school reopening (August-September-October), during which time parents invest heavily in fees, books, uniforms, clothing, shoes, and household provisions (rice, pork, fish, meat). Cassava varieties that have good processing qualities (high dry matter content, produce shiny products, have white roots and leaves, are heavy, thick, and have a sticky consistency when cooked) as discussed in Chapter 5, Section 5.5, play an important role in this case and are therefore highly valued.

The ability to harvest cassava piecemeal spreads the income generated through sales of cassava and cassava products throughout the year. This small but steady stream of income helps women to supplement their family's daily nutritional needs especially for protein (smoked and fresh fish, meat) and for those food items that they do not produce, to provide school stationery for children (pencils, pens, rulers, exercise books) and to make monthly and periodic financial contributions in their social and political gatherings as well as toward important feasts (marriages, births, deaths etc). Here are some excerpts of conversations held with two Koudandeng women: "I belong to the social gathering of sisters of Sa'a origin where I save money and contribute financially towards sad and good events that happen to our fellow sisters. We sew new uniforms every two years, which costs a lot of money. When I have enough cassava in the field, I am happy because I can easily make these contributions" (Celine); "We celebrate the International Day of the Woman on the 8^{th} of March each year and so each year we sew a new uniform. I must always have cassava in my fields so as enable me buy my uniform and feel important as other women" (Marie-Claire).

Credit is important for establishing and managing food crop fields (including cassava-based polyculture fields). Bush clearing, tree felling, and second and third weedings require high expenses, which often coincide either with periods when cash is needed for other activities or to pay for health services and treatment in case of serious illness (farmers or their relations). Farmers rely either on the sale of food crops (especially cassava) or credit to carry out these crucial farming activities. The main sources of credit are farmers' local credit institutions (ethnic and social associations, farmer organisations). Conditions for obtaining credit from these institutions include, among others, membership and a high level of credibility. Credibility refers to having enough savings, making financial contributions to others, regular payment of interest on loans, and rapid loan repayment. Women rely mostly on income from cassava production to fulfil these conditions and increase their eligibility for future loans. Women also save part of the income they obtain from cassava in these credit institutions to safeguard against financial difficulties encountered during school reopening and periods of festivities. These savings and interests from loans are shared either in August or at the end of the year (November-December).

6.4.1.5 Managing labour and land constraints

Smallholder farmers strongly rely on own and family labour for their agricultural activities (Ellis, 1992) and attempt to maximise their leisure time, as well as avoid labour bottlenecks, by minimising labour requirements. Polyculture is an important strategy for doing so. Farmers' strategy for controlling weeds in their polyculture fields through crop combinations was discussed in Chapter 4, and weeding is a crucial activity in the life cycle of crops. Apart from weed control, farmers combine crops in the same field to facilitate the provision of food for their households and for sale. At the end of a hard day's work, women harvest and carry home the various food crops that are required for a meal. This demands less labour when most or all of the crops are grown in the same field compared to when they are managed in various monoculture fields, which may be quite distant from each other. Women also fetch fuelwood alongside food items from incompletely burned tree trunks and branches and trees that are left standing in their fields.

Hiring labour, especially for land clearing and weeding, is a labour supply strategy. Some 23% and 5.8% of Malende and Koudandeng cassava farmers, respectively, employ hired labour for weeding to free themselves of the heavy burden and maximise time for other activities or leisure. Labour exchange is another source of labour that women in Malende and Koudandeng adopt. Women form social groups whose members assist each other in implementing their agricultural activities in rotation. According to women, labour exchange or communal labour lightens their burdens and time devoted to weeding large fields compared to doing this alone. The thought of weeding large fields alone fatigues them.

Koudandeng and Malende are both patriarchal societies where women have usufruct rights to land for food crop production, whereas men own land. This traditional land tenure regime often limits women's access to farmland and decision making with regard to which portion of land to use for annual crop production. Women's management of polyculture fields obviates the difficulties they would encounter with men if they had to negotiate access to the land necessary to manage many monoculture fields. The ethnic diversity of Malende (10 ethnic groups) was discussed in Chapter 2, where it was noted that many migrants are landless and depend on rented land for agriculture. Polyculture is most suitable for these landless farmers who would confront financial limitations if they had to rent numerous fields for monoculture production to produce a large number of crop species.

In summary, farmer's nutritional, socio-cultural, spiritual, and health needs, interests and priorities determine the types of crops that they grow. These factors are intertwined in a complex web of livelihood strategies of Koudandeng and Malende farmers. Policies that emphasise only food and income needs of farmers may act in detriment to other socio-cultural values that farmers attach to their varieties and cropping systems, which also inform how they perceive and relate to the natural, social, and spiritual worlds. Such policies may have negative implications for food security and farmers' and farm households' well being if farmers adopt the HYVs and production systems that AGRA and others promote. Biological, socio-cultural, spiritual, and health factors that shape farmers' decision making frameworks determine which cassava varieties they manage, and should be considered as a whole system and not in isolation when formulating food security and agricultural policies.

6.4.2 Foodways, Household Food Security, Polyculture Crop Production, and Cassava Cultivar Diversity

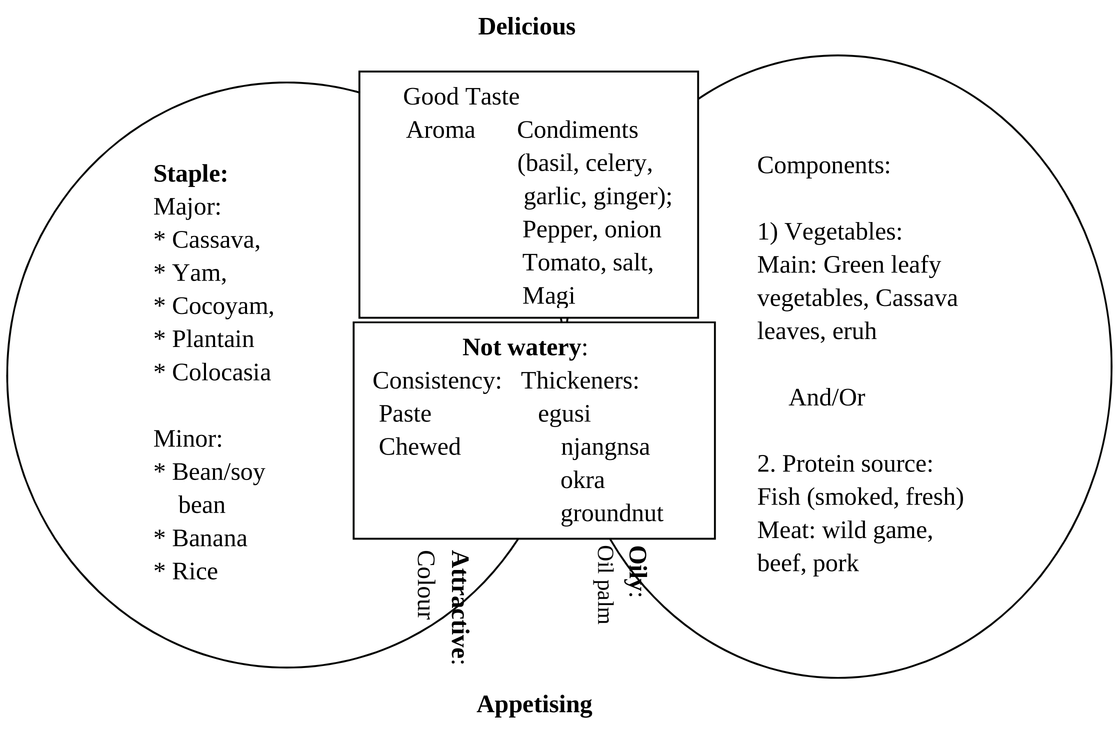
In this section, I contest AGRA's assertion that African farmers' local crop varieties do not produce high yields and therefore harvests are not reliable, thus making most households food insecure, and that breeding and disseminating HYVs will lead to abundant and more reliable harvests. It argues that Koudandeng and Malende households do not face problems of food insecurity and that it is their own food choices and preferences and those of other local populations that determine which crops they grow and sell in local markets. Farmers' strategies for ensuring household food and nutrition security are determined by local foodways, which in turn influence farming systems and crop diversity. These strategies include: i) supplying most household food needs through own production, ii) selling surplus production to earn income to purchase the food items that they do not produce, iii) managing many food crop fields as complementary production and consumption spaces, iv) orienting their production toward ensuring year-round availability of food, and v) redistributing food through gift giving.

6.4.2.1 Household food production, nutrition and security

Food is essential for human health and well-being, but it is more than just a source of nutrients. Food is a key component of one's culture and is central to one's sense of identity (Koc and Welsh, 2002). The concept of foodways refers to a group's food choices and preferences, methods of food preparation and consumption, number of meals per day, meal times, and size of portions eaten. These constitute part of a consistent cultural pattern in which each custom and practice has a part to play. The local foodways of Koudandeng and Malende peoples determine the crops that are grown and sold in local markets. New crop varieties that are bred to increase yields may not integrate well with such foodways, which may lead to food and nutrition insecurity as well as cultural and genetic erosion.

In Chapter 2, it was shown that the food crops grown in Koudandeng and Malende include: i) oil palm, African plum, orange, avocado, mango, bitter kola, njangsang, pineapple, plantain and banana, and sugar cane as perennial and semi-perennial crops; ii) groundnut, cocoyam, maize, cassava, egusi, sesame, sweet potato, bean, soy bean yam (sweet yam, yellow yam, white yam, calaba yam), and colocasia (taro) as annual crops; and iii) pepper, okra, onion, tomato, and green leafy vegetables (green, bitter leaf, okongobong) as vegetables. Celery and basil are grown as condiments, while njangsang, bitter kola, and eruh are wild plants that are harvested from brush and forest. Households consume dishes that are constituted of various combinations of these crops and wild food plants. A meal, which is culturally defined as a main staple (a source of energy) that is eaten with a relish (vegetable, protein) or a staple prepared in the form of porridge, must be delicious and appetising (the right colour, attractive; oily, not watery) (Figure 6.3).

Figure 6.3 Relationship between the Cultural Conception of Diet and Farmers' Crops



Traditionally, meals are eaten thrice a day, at breakfast, mid-day, and evening, and the quantity consumed per meal depends on the individual. The energy foods (carbohydrates) or staple crops consist of cassava, plantain, colocasia, cocoyam, yam, rice, banana, and beans, whereas the components of a vegetable relish include various types of green leafy vegetables (green, okongobong, huckleberry, waterleaf, etc.) or vegetable fruits (okra), cassava leaves, or eruh. Protein sources may or may not be added to the vegetable relish. Beans are most often consumed as a relish rather than as a staple. Figure 6.3 depicts the relationship between the way that traditional meals are culturally conceived and farmers' crops in the study area.

A relish must have good taste and aroma and, as such, condiments (basil, celery, garlic, and ginger), pepper, onion, tomato, and bullion ('Magi') cubes and salt are used as flavourings, as is a source of protein, if available. The staple (carbohydrate) that is eaten with the relish should have good taste and aroma, otherwise it is considered tasteless. According to farmers, food should not be watery and therefore their staple food items are either eaten in the form of a paste (boiled and pounded, milled, and cooked into a sticky porridge) or boiled and eaten fresh. Thickeners such as groundnut, egusi, njangsa, okra, and groundnut are used to thicken soups.

Colour is an important measure of attractiveness. Food items that are not white in colour or have their original [raw] colour when cooked are considered to be unattractive and therefore unappetising. Appetising soups/relish should also be oily, which is a quality that is obtained through the use of palm oil, which is extracted from palm nuts [nuts of *Elaeis guineensis*]. Even though groundnut, njangsa, and egusi are oil seeds, they are not used mainly as a source of dietary oil in Malende and Koudandeng. In Malende, beans are often eaten as a major ingredient in soup and are consumed sparingly as a source of energy, serving mainly as a source of protein.

Fruits (mango, African plum, avocado, pineapple) are eaten raw and, whenever people wish, according to their production season and the specific fruit. For example, the peak production of mangos and African plum ranges between May and October in the study sites, whereas pineapple and avocado fruit throughout the year.

Various traditional dishes are prepared, where the most common are depicted in tables 6.1 and 6.2. Although in both villages most households frequently eat rice, it is not a traditional dietary staple and thus is not included in the tables. Muengwalla is also not included in Table 6.1. Tables 6.1 and 6.2 highlight the fact that the food combinations, and therefore traditional diets, are varied and differ for the two villages, which reflects inhabitants' diverse ethnic origins. While it is easy to classify the traditional diets according to the importance of different staple foods in the more ethnically homogenous Koudandeng, classification in more ethnically diverse Malende (other than cassava, which everyone eats), is more difficult.

As can be seen in tables 6.1 and 6.2, cassava and cassava products occupy a central place in the traditional diets of the two villages. It is grown for own consumption and sale and is either eaten boiled or processed (boiled and pounded, pounded, milled, grated, fermented, and distilled). The cassava products eaten in Koudandeng (Table 6.1) include: ndeng (baton), boiled fresh roots, raw fresh roots, vouvou (couscous or cassava flour), beigner (fried cassava and ripe banana paste balls), chips, kwem, and muengwalla. In Malende, cassava is eaten in the following forms: gari, water fufu, myondo (miondo), boiled fresh roots, fufu (pounded boiled roots), and makra (Table 6.2).

Table 6.1 Common Traditional Dishes in Koudandeng

Order of importance	*Staple (energy source)*	*Traditional Consumption Form*	*Accompanying soup*			
			Vegetable soup with no animal protein	*Vegetable soup with animal protein*	*Animal protein soup or source*	*Other Soups*
1st	Cassava	Ndeng (baton)	Kwem (cassava leaves, groundnut, palm nut pulp)		Smoked/fresh fish or wild game soup or Fried/roasted fish	*Groundnut or egusi pudding *Roasted African plum *Avocado
		Boiled fresh roots				
		Raw fresh roots				
		Vouvou (Couscous)		Green leafy vegetables + fish or wild game + palm oil	Smoked/fresh fish or wild game soup + palm oil	
		Beigner (fried cassava balls)				Spiced pepper sauce
		Chips (masoma)				
2nd	Sweet potato	Boiled roots	Kwem	Green leafy vegetables + fish or wild game + palm oil	Smoked/fresh fish or wild game + palm oil	*Groundnut/ egusi pudding *Roasted African plum *Avocado
3rd	Maize	Sanga (fresh corn + pounded cassava leaf porridge)				
4th	Plantain	Pounded	Kwem	Green leafy vegetables + fish or wild game + palm oil	Smoked/fresh fish or wild game + palm oil	
		Boiled fingers				
5th	Cocoyam	Boiled tuber	Kwem			

Source: Interviews with female and male farmers and observations.

Table 6.2 Common Traditional Dishes in Malende

Staple (energy source)	*Traditional consumption form*	*Accompanying soup*		
		Vegetable soup with or without animal protein	*Animal protein soup or source*	*Other Soups*
Cassava	Gari	Green leafy vegetables + egusi +/ fish or beef	Beef or fish +/ okra + palm oil	
	Gari snack (gari soaked in cold water+/ sugar			
	Water fufu	Eruh + beef or cattle skin and trips or snail + palm oil	Beef or fish or snail + palm oil	
	Fufu	Green leafy vegetables + egusi +/ fish or beef	Beef or fish + okra + palm oil	
	Boiled roots			*Egusi or groundnut pudding *Roasted African plum/ Avocado
	Myondo (miondo)		Roasted beef or fish	
	Makra (fried cassava balls)			Spiced pepper sauce
Colocasia	Achu		Beef, cattle skin and tripe + palm oil	
Maize	Boiled fresh			
	Corn chaff (corn + bean porridge)			
Bean				
Plantain	Boiled fingers	Green leafy vegetables + fish or beef + egusi or groundnut	Beef or fish + egusi or groundnut + palm oil	Bean porridge
Cocoyam	Boiled tubers			
	Fufu or esouba (pounded cocoyam)			
	Ekwang (porridge made from grated cocoyam tuber + cocoyam leaf or green)			

Source: Interviews with female and male farmers and observations.

The procedures for making each cassava product and its mode of consumption are depicted in figures 6.4 and 6.5. Except for gari, masoma (chips), muengwalla, and kwem, which are not similar and where processing methods differ between the villages, all of the other cassava products are similar, where what varies are the steps in the processing process. For example, beigner and makra are the same products with different names, and myondo (miondo) and ndeng (baton) are the same products but they vary in their size and method of wrapping; water fufu and vouvou (couscous) are similar, but couscous takes longer to process and involves sun drying, whereas water fufu must be pressed to release water. While gari is mainly processed in Malende, masoma (chips), muengwalla, and kwem are mainly processed in Koudandeng. Kwem is the main vegetable soup/relish in Koudandeng.

Varietal diversity and foodways are therefore intimately related. For example, when explaining the very large number of potato and maize cultivars that Andean farmers maintain, Zimmerer (1996) found that agroecological factors explained only about a third of the total diversity, whereas culinary and processing requirements explained the rest. Howard et al. (2008) reported that studies on cassava cultivar diversity in Amazonia report that the use of bitter versus sweet varieties is often related to culinary traditions rather than to agronomic requirements. All of the palatability and processing qualities that determine the suitability of different cassava varieties for making traditional cassava products are related to cassava varietal diversity in Malende and Koudandeng. A common saying among farmers is, “It is good for baton, couscous, beigner, gari, water fufu, and muengwalla” and, “It is good to pound into fufu.” Farmers’ interest in obtaining and maintain varieties that can be used for making different cassava products leads to varietal diversity maintenance, which in part ensures food security for their households since a greater proportion of the products are consumed daily, year-in-year-out.

It was reported in Chapter 5 that 28 and 16 cassava varieties are managed in Koudandeng and Malende, respectively, and that good processing qualities, suitability for making specific products, and palatability, among others, were significant varietal evaluation criteria for farmers in both villages. These varietal diversity and evaluation criteria are a reflection of farmers’ traditional dietary patterns (the different forms in which cassava is eaten).

a) Palatability and cassava diversity

As discussed above and in Chapter 5, palatability is measured in terms of taste, colour, and texture of fresh roots and processed products. In Koudandeng, 24 out of the 28 varieties that are managed are sweet. In Malende, four varieties are sweet: Red skin (tuber peel), Red skin short branching, Yaounde, and Yellow stick. According to farmers, sweet varieties are palatable and are usually boiled and eaten fresh, and thus considerable processing time is saved. Koudandeng farmers also evaluate the sweet varieties in terms of fibre content and ease of chewing, since these varieties are also eaten raw either as food or to enhance male fertility (see Section 6.1). Palatability is also measured by water content, flavour, and aroma, and both bitter and sweet varieties that have desirable qualities are maintained. Varieties that are considered to be good tasting include: Kumba black stick, Yaounde, and Kumba white stick, in the case of Malende, and Fonctionnaire, Mbokani, Mintole minko, Muane moung, Ikwemi, Menyo mbandjock, Ntangne, Six mois doux, Menyo local, Sanegai, Meboura, Moung eligedja nanga, Apoba moung, and Nkodouma, in the case of Koudandeng.

Figure 6.4 Some Traditional Cassava Products and Processing

a) Gari

b) Preparing water fufu and eruh to cook

c) Makra or Beigner frying

d) Gari sieving and toasting

Figure 6.4 Some Traditional Cassava Products and Processing (con't.)

e) Wrapping ndeng (baton)

f) vouvou or nkum-nkum (couscous) must be milled before cooking (same process as for miondo)

Colour as a measure of palatability is viewed in terms of the glossiness of the cassava product. Varieties that are white when boiled or processed, such as Fonctionnaire, Mbokani, Muane moung, Menyo mbandjock, Ikwemi and Apoba moung, are highly valued in Koudandeng, and Kumba black, Kumba white stick, and Yaounde varieties are valued in Malende. Also, varieties that produce glossy gari are highly valued in Malende.

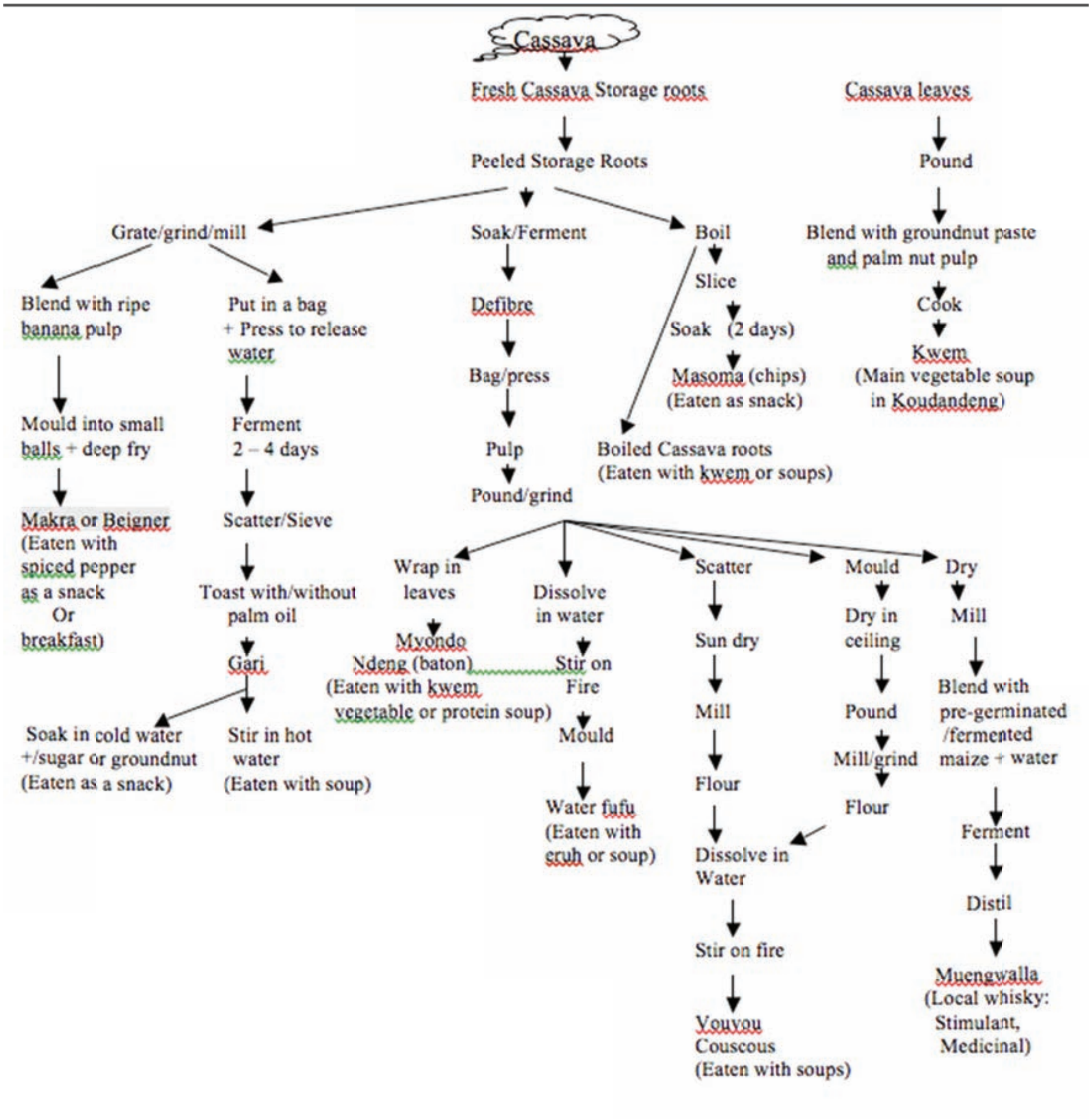
As a measure of palatability, texture is viewed in terms of gelatinous (sticky and elastic) quality, weight, and smoothness of processed products and fibre content of boiled roots. For example, varieties which produce gelatinous baton, couscous, gari, and water fufu when cooked, as well as pounded fufu, are highly valued. Malende farmers also maintain varieties that produce heavy gari, water fufu, and pounded fufu, because heaviness is seen as an indicator of the ability to stave off hunger and provide sustenance over a long period (many hours per day). A common saying in Malende is, "Kumba black stick, Kumba white stick, and Red skin cassava fill the stomach."

b) Processing qualities and varietal diversity

Farmers evaluate and select varieties in accordance with the characteristics desired for making the different products into which cassava is processed in both villages, which contributes to cassava varietal diversity. Processing qualities are considered in terms of dry matter content, ease of processing, and root mealiness. In relation to dry matter content, farmers often say, "It raises paste," or "It does not raise paste very much;" "It shrinks paste," or "It is too watery". According to them, varieties that have high dry matter content (less water) increase the volume of processed products, whereas varieties with much water (such as the HYVs) reduce the volume. All of the local varieties that are less watery, especially Muane moung, Mintole minko, Fonctionnaire, and Ikwemi, in the case of Koudandeng, and Kumba black stick and Kumba white stick, in the case of Malende, are highly valued and commonly grown, whereas the research HYVs are generally not highly valued for their processing qualities. However, about three percent of Koudandeng farmers indicated that the research HYV called Irad is preferred for its processing qualities since it does not take long to soak; it is very watery and therefore easily processed. In Koudandeng, some farmers prefer varieties whose leaves are soft to pound when making kwem (such as Muane moung and Sanegai).

Root mealiness is evaluated in terms of soaking and cooking time and fibre content. In Koudandeng, varieties that take long to soak, such as Ikwemi, have a lower value compared to those that soak quickly. Farmers also prefer varieties that do not take long to cook, i.e. that cook at most in 30 minutes. These include Muane moung, Menyo mbandjock, Yaounde, and Yellow stick. Women explained that, when faced with labour constraints, they prefer varieties that cook quickly and thus save time for other activities, especially in the mornings and evenings. Varieties that cook quickly also have low root fibre content. Varieties with high root fibre content, such as Ikwemi, are often very hard and sometimes woody, which increases cooking time.

Figure 6.5 Processing Procedures for Some Common Traditional Cassava Products



It should be noted that different cassava varieties have different combinations of characteristics. Whereas one might not be as palatable, it may take less time to cook. The 'ideal' variety doesn't exist, so farmers maintain a range of varieties that have specific traits. For example, in Koudandeng, the variety called Ikwemi has good taste, increases the volume of processed products due to its high dry matter content, and produces white and shiny products when processed, but its roots are fibrous and are hard to cook and chew. In Koudandeng, the HYV variety called Irad is said to be watery, which decreases the volume of processed products; it is bitter and has poor taste, but it produces smooth baton and couscous. In the case of Malende, the HYV called Agric short is considered to be watery; it does not increase the volume of processed products, produces low weight processed products, and must be mixed with other, less watery varieties, such as Kumba black stick, but the gari and water fufu that it produces are shiny.

c) Crop associations in relation to foodways

Farmers' traditional polyculture systems and the crops that they choose to grow in association are in part based on local foodways. The different traditional meals in Malende and Koudandeng are presented in tables 6.1 and 6.2 above, while the discussion on traditional farming systems in Chapter 2 lays out the different polyculture food crop fields. One series of objectives that farmers have in managing these fields is to ensure food self-sufficiency and fulfil traditional dietary preferences insofar as possible. As such, they plant a combination of crops to fulfil their food traditions and needs for dietary diversity. For example, a plantain/banana-based polyculture field in Koudandeng in which plantain, banana, cassava, cocoyam, groundnut, and African plum are planted as companion crops, provides at least nine different dishes:

- Boiled plantain fingers that are eaten either with kwem (cassava leaves), groundnut pudding, or other vegetable and animal protein source soups;
- Pounded boiled plantain fingers that can be eaten with kwem or other vegetable and animal source protein soups;
- Ndeng (baton) that is eaten with kwem, groundnut pudding or other vegetable and animal protein source soups;
- Vouvou or nkum-nkum (couscous) that is eaten with kwem, other vegetable and animal protein soups;
- Boiled cassava roots that are eaten with kwem, groundnut pudding, other vegetable and animal protein soups;
- Beigner that is eaten as a snack with spiced pepper sauce;
- Masoma (chips) that is eaten as a snack;
- Boiled fresh cocoyam tubers that are eaten with kwem, groundnut pudding and other vegetable and animal protein soups;
- Groundnuts serve as soup thickeners and as soups (pudding), while cassava leaves serve as the main vegetable for the soup called kwem that is eaten with all dishes;
- African plum and banana are fruits that serve as deserts.

A cassava-based polyculture field that contains groundnut, cassava, plantain, maize, cocoyam, green leafy vegetables, and okra (Table 4.1 in Chapter 4) as companion crops provides at least eight traditional dishes: four cassava-based dishes (baton, couscous, boiled roots, beigner), boiled plantain finger, cocoyam tuber, maize dishes, and maize and kwem (cassava leave) porridge, while cassava leaves and groundnut serve as the main source of soup and soup thickeners. A cassava-based polyculture field that contains cassava, maize, egusi, groundnut, water yam, sweet yam, and pepper as companion crops provides 10 different traditional diets for a household in Malende: six cassava-based diets (gari snack, gari meal, water fufu, pounded fufu, miondo and makra), boiled maize, corn chaff, water yam and sweet yam dishes.

In the case of Malende, a cocoyam-based polyculture field in which cocoyam, maize, groundnut, egusi, cassava, colocasia, green leafy vegetables, and plantain are grown in association provides between 10 and 13 different traditional dishes, depending on the ethnic origin and food habits of the farmer:

- Pounded cocoyam that is eaten with vegetable, egusi, or animal protein soup;
- Boiled cocoyam tubers that is eaten with vegetable, egusi, or animal protein soup;
- Ekwang, which is a porridge made of grated cocoyam tubers tied in young cocoyam leaves;
- Corn chaff, which is a maize and bean porridge;
- Boiled fresh corn;
- Achu, which is made from pounded colocasia tubers;
- Boiled plantain fingers that are eaten with vegetable, egusi pudding, or other animal protein soups;
- Gari, which is either soaked in cold water and eaten as a snack or stirred in hot water and eaten with vegetable, egusi, or animal protein soup;
- Water fufu that is eaten with eruh, other vegetable and animal protein soups;
- Fufu cassava that is made out of pounded boiled cassava roots and is eaten with vegetable, egusi, and animal protein soups;
- Boiled fresh roots that are eaten with egusi pudding, vegetable, and animal protein soups;
- Miondo that is eaten with roasted fish, egusi pudding, vegetable, and animal protein soups;
- Makra, which is eaten with spiced pepper sauce as a snack;
- Green leafy vegetables serve as the main source of vegetable soups and egusi serves as a soup thickener and as a main soup in the form of pudding.

Referring to tables 4.1 and 4.2 in Chapter 4, it can be observed that the production patterns in these fields differ between Koudandeng and Malende, which reflects the variation in dietary patterns. Apart from groundnut, cassava, and maize, which are major crops in both villages, egusi is a major crop in Malende, whereas plantain, cocoyam, and green leafy vegetables are major crops in Koudandeng. While groundnut is a major crop in both villages, only half of all farmers grow it in Malende, whereas all women farmers in Koudandeng grow it. Groundnut plays a major role in Koudandeng's traditional diet: it is the main source of soup thickener in kwem and is also eaten as groundnut pudding. In Malende, egusi is grown by three quarters of all households where it is used as the main source of soup thickener and pudding, whereas only 11% of Koudandeng women farmers grow it. In Koudandeng, egusi is traditionally a male crop, which was used in bride price payment even though it has since been replaced by cash (Papa Bonaventure, 79 years old). Koudandeng cassava-based polyculture fields tend to contain most of the food items that could be combined to make complete meals relative to Malende cassava-based polyculture fields, which mostly contain staple and soup thickening crops whose preparation into a full meal require vegetables that are grown in other fields (refer to tables 4.3 and 4.4 in Chapter 4).

The variation in the cropping pattern and type of crops grown in a cassava-based polyculture field by ethnicity is depicted in Table 6.3. Cassava is grown by all of the ten ethnic groups studied. Except for the Bayangi, who do not grow maize, egusi, and groundnut in association, cassava, maize, egusi, and groundnut constitute major crops in the fields of farmers from the other nine ethnic groups. Menemo/Moghamo farmers grow all of the crops in association although in varied proportions. Bakossi and Tikari farmers grow mainly root and tuber crops, egusi, pepper, and groundnut in association, which may be due to the fact that their traditional diets consist of pounded cocoyam (esouba) for the Bakossi, and achu or ndiay for the Tikari.

6.4.2.2 Food production, consumption, sale, redistribution and food security

Here, the assumptions underlying the breeding and release of HYVs to ensure abundant and reliable harvests are questioned. One assumption is that most rural African households are food insecure, and another is that they lack income to purchase necessities that they don't themselves produce. Here it is argued that these assumptions deal mainly on the volume and stability of food crop production and the presumption that food sales are the ultimate goal, while neglecting the multiple goals that farmers have when managing food crop fields. One such goal is to meet social obligations related to food sharing, which ensures social access to food as well as creating and maintaining social relations between individuals and households.

It was beyond the scope of this research to actually measure whether household members are malnourished or food insecure. The discussions on crop associations and traditional foodways above, however, highlights the fact that Malende and Koudandeng farmers grow most of the food that their households consume. It is argued below that sufficient food and diversity of foodstuffs are produced year-round to meet household consumption needs, to generate income, and to redistribute food (give it away). Farmers are not desperate; to the contrary, they are able to produce not only what they consume, but also to process for sale, which enables them to purchase high protein food and other food that they do not produce. It is thus quite difficult to surmise that Koudandeng and Malende farmers are food insecure if they sell and share so much food. It is argued that farmers' main objective is to ensure food self-sufficiency and security, and so most farm produce is either consumed or shared, with surpluses sold to enable households to obtain the food items that they cannot produce, as well as to cover other social and household obligations (children's education, health care, and contributions to social groups). On this basis, it can be said that Koudandeng and Malende cassava farmers do not confront problems with food security and malnutrition, since they grow most of the food that their households need in their traditional intercropped fields.

Table 6.3 Variation in Crop Diversity in Cassava Based Polyculture Systems

Ethnic Group	*% Households Growing Crop in Association in a Cassava Based Polyculture Field*															
	Cassava	*Egusi*	*Maize*	*Ground-nut*	*Coco-yam*	*Plan-tain*	*Banana*	*Colo-casia*	*Calaba Yam*	*Sweet Yam*	*Water Yam*	*Sweet Potato*	*Green Leafy vegs.*	*Pepper*	*Oil Palm*	*Cocoa*
Native	100	75	100		50	25			25	25			25	25		
Menemo/ Moghamo	100	72	61	50	33	11	6	6		22	11	6	11		6	
Bayangi	100					100									100	100
Bakossi	100	100	100		50							50				
Bangwa	100	44	100	44	44	11		11		33	11			11		
Tikari	100	100	67	67	33			33								
Abo-Douala	100	100	100	75	75					25	25					
Bakndo-Ndam	100	100	100	100	50					50		50				
Aghem/ Beba/ Modele	100	100	83	67	33	17					17	17				
Bameleke	100	100	100	100	33											

Source: Household survey.

a) Own consumption versus sales and gift giving

The proportion of farmers' total food crop produce that is devoted to household consumption, sale, and gift giving are depicted in tables 6.4 and 6.5. The data represent estimates regarding the destination of production based on farmers' recall collected in the household and cassava surveys (see Appendix X and Y), and show that ensuring physical and social access to food and income generation are three important objectives for growing different crops in both villages. Based on these objectives, five production orientations can be identified in relation to specific crops. To meet these objectives, a diversity of crops is grown. Specific crops are grown for:

- Household consumption only,
- Sale and household consumption
- Sale only
- Household consumption and gift giving
- Household consumption, sale, and gift giving

Farming households eat all of the food crops that they grow, although in varied proportions. For example, except for cassava, which in Malende is mostly sold, a higher percentage of all roots and tuber crops and plantain/banana are eaten in comparison with pulses, cereals, and vegetables in both villages. Traditional foodways are more oriented toward roots and tubers and plantain/banana. Except for maize, which is grown in greater quantities in Koudandeng, these staples are also grown in greater quantities relative to all of the other cereals, pulses, and legumes. Most farmers in the study sites indicated that they grow green leafy and fruit (okra, tomato, onion) vegetables in small quantities that are harvested piecemeal, mainly for household consumption. They do not recall the exact quantities produced.

Table 6.4 Proportion of Some Farm Produce Consumed, Shared and Sold by Malende Households

<table>
<tr><th colspan="2" rowspan="2">Food Crop</th><th rowspan="2">Total Prod./yr (kg)</th><th rowspan="2">% HH Growing</th><th colspan="2">Proportion Consumed</th><th colspan="2">Proportion Sold</th><th colspan="2">Proportion Given Away</th></tr>
<tr><th>%</th><th>% HH</th><th>%</th><th>% HH</th><th>%</th><th>% HH</th></tr>
<tr><td colspan="2">Cassava roots</td><td>1047120</td><td>100.0</td><td>27</td><td>83.3</td><td>73</td><td>93.3</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Cocoyam</td><td>49560</td><td>87.0</td><td>59</td><td>83.9</td><td>41</td><td>16.1</td><td>2.7</td><td>13.3</td></tr>
<tr><td colspan="2">Maize</td><td>3295</td><td>53.3</td><td>31</td><td>50.0</td><td>52</td><td>47</td><td>17</td><td>50</td></tr>
<tr><td colspan="2">Groundnut</td><td>3015</td><td>57.0</td><td>17</td><td>50.0</td><td>74</td><td>43.3</td><td>9</td><td>53.3</td></tr>
<tr><td colspan="2">Egusi</td><td>7033</td><td>73.3</td><td>21</td><td>56.7</td><td>70</td><td>70</td><td>10</td><td>53.3</td></tr>
<tr><td colspan="2">Plantain</td><td>22890</td><td>53.3</td><td>31</td><td>53.3</td><td>43</td><td>36.7</td><td>22</td><td>43.3</td></tr>
<tr><td rowspan="4">Green Leafy Vegetable (fresh wt.)</td><td rowspan="2">Green
Water leaf</td><td>840</td><td>6.7</td><td>20.2</td><td>6.7</td><td>76.2</td><td>6.7</td><td>3.6</td><td>6.7</td></tr>
<tr><td>90</td><td>3.3</td><td>10</td><td>3.3</td><td>90</td><td>3.3</td><td>-</td><td>-</td></tr>
<tr><td>Huckleberry</td><td>1240</td><td>3.3</td><td>80.6</td><td>3.3</td><td>19.4</td><td>3.3</td><td>-</td><td>-</td></tr>
<tr><td>Okongbong</td><td>266</td><td>3.3</td><td>9</td><td>3.3</td><td>90.2</td><td>3.3</td><td>0.8</td><td>3.3</td></tr>
<tr><td colspan="2">Tomato</td><td>244</td><td>3.3</td><td>3</td><td>3.3</td><td>96.4</td><td>3.3</td><td>0.6</td><td>3.3</td></tr>
<tr><td colspan="2">Okra</td><td>20580</td><td>6.7</td><td>1.8</td><td>6.7</td><td>97.8</td><td>6.7</td><td>0.4</td><td>6.7</td></tr>
</table>

Source: Household and cassava survey, 2006 - 2007

Table 6.5 Proportion of Some Farm Produce Consumed, Shared and Sold by Koudandeng Households

Food Crop	*Total Prod./yr (kg)*	*% HH Growing*	*Proportion Consumed*		*Proportion Sold*		*Proportion Given Away*	
			%	*% HH*	*%*	*% HH*	*%*	*% HH*
Cassava roots	381520	100	65	100	35	73.3	-	-
Cocoyam	6470	46.7	74	46.7	26	26.7	-	-
Yam	2720	26.7	74	26.7	26	13.3	-	-
Sweet potato	4690	23.3	46	23.3	54	20	-	-
Groundnut	6845	100	49	100	43	56.3	8	37.5
Maize	228560	82	39	82	56	52	5	27.3
Banana	13675	44	71	26.5	21	41.2	3	29.4
Plantain	14995	50	75	32.4	23	47	4	32.4
Pepper	135	3.1	11	3.1	78	3.1	11	3.1
Green	307	53	100	53	-	-	-	-
Tomato	2945	11.8	8	11.8	87	11.8	4	8.8
Okra	205	5.9	51	5.9	29	5.1	20	5.9

Source: Household and cassava survey, 2006 -2007

Koudandeng households consume cassava roots, leaves, and processed products in varied proportions (Table 6.6). For example, cassava is consumed principally as boiled fresh roots and pounded fresh leaves, where 65% and 89% of total produce is consumed, respectively. Some 30% of the total fresh roots harvested are processed into baton, couscous, and beigner. Of these, baton is the main processed product that is produced by 50% of the households who nevertheless consume less than 20% of the total product. Over one third of the households process couscous and consume about 10% of total produce. Only one or two households process beigner. Four types of processing households were identified: i) those that process baton only (24%); ii) those that process couscous only (6%); iii) those that process baton and couscous (29%); iv) those that process only beigner (3%); and v) those that do not process at all (39%). Of those that process cassava, only a third are young (<40 years old). Processed cassava products can be purchased when needed, and young women avoid expending large quantities of labour in processing. “I do not like processing cassava because I do not have time and, moreover, I can always buy baton when I want,” explained Sabine (32 years old).

As regards the amount of time required to process each of these products (which translates roughly into labour requirements), women indicated that baton processing takes at least five days distributed as follows: i) between one and two days for harvesting, transporting, and peeling; ii) between two and three days for soaking; and iii) one day for grinding and wrapping the fermented paste in leaves and boiling. The duration of processing depends on the quantity processed and the varieties. Varieties that are not hard to soak (have moderate dry matter content) such as Mekoughe, Ntangne, Mbokani, Muane moung, and Mintole minko take fewer days to process compared to varieties that are difficult to soak. Varieties that have very high dry matter content, such as Ikwemi, take four to five days to soak and are called “varieties that are hard to soak”. An observation of the baton wrapping and cooking process in two households showed that it takes about 15 hours to wrap and cook large quantities of cassava paste (500 sticks of baton). Pounding and cooking cassava leaves into kwem takes at least four hours, depending on the quantity. Couscous processing takes at least eight days (one to two days for harvesting, transporting, and peeling; two to four days for soaking; grinding/milling and pressing to release excess water takes a day; drying in the sun takes two days) depending on the variety and quantity processed. Some women indicated that ground or pounded fermented cassava roots produce better quality (better texture) baton and couscous compared to mechanically milled roots, although the latter takes less time.

Table 6.6 Koudandeng Households Own Consumption versus Sale and Gift Giving of Cassava and Cassava Products

Cassava Product	*Total Produced/yr*		*Proportion Consumed*		*Proportion Sold*		*Proportion Given Away*	
	kg	*% HH*	*%*	*% HH*	*%*	*% HH*	*%*	*% HH*
Cassava Leaves (fresh wt.)	9517.5	100	89	100	11	24.2	-	-
Cassava roots (fresh wt.)	381520	100	65%	100	5%	67.6	-	-
Baton (fresh wt.)	21726.4	52.9	16	52.9	83	38.2	1	29.4
Couscous (dry wt.)	6965	35.3	11	35.3	86	29.4	2	17.6
Beigner	3600	3	1	3	98	3	1	3

Source: Household and cassava survey, 2006 - 2007

Unlike the case with Koudandeng, where cassava leaves and roots are staples, Malende households do not seem to eat any one form more than the other (Table. 6.7).

Table 6.7 Malende Households Own Consumption versus Sale and Gift Giving of Cassava and Cassava Products

Cassava Product	*Total Produced/yr*		*Proportion Consumed*		*Proportion Sold*		*Proportion Given out*	
	kg	*% HH*	*%*	*% HH*	*%*	*% HH*	*%*	*% HH*
Fresh Roots	1047120	100	27	83.3	7.2	3.2	-	-
Gari (dry wt.)	113850	87.1	8	87.1	91	87.1	1	20
Water fufu (fresh wt.)	6980	38.7	8	38.7	87	25.8	5	13.3
Kumkum (couscous) dry wt.	3360	3.2	12.5	3.2	87.5	3.2	Small qty	3.2

Source: Cassava survey 2007

However, in Malende, most households eat pounded boiled fresh roots in greater proportions relative to processed products. Some two-thirds of all cassava fresh roots are processed compared to Koudandeng, which processes only 30%. Out of the three processed products, over 80% of the households produce gari, whereas a third process water fufu. Households consume less than 10% of their total produce, which would tend to imply that they are not food insecure. Five types of households were identified in Malende: i) those that process all three products (3.2%); ii) those that process water fufu and gari only (30%); iii) those that process gari only (56.7%); iv) those that process water fufu only (6.7%); and v) those that do not process cassava (6.7%).

In relation to the labour time involved in processing, interviews with some women farmers and observations indicated that it takes at least six days to process gari depending on the quantity: harvesting, transporting, and peeling one push-truck (250 kg) of cassava roots takes one to two days; grinding/milling (using motorised graters) and pressing to release water takes two to four days, depending on the season; and toasting takes one to two days. Hand grating cassava roots is tedious and takes about two to three days for large quantities. Water fufu processing takes eight days, depending on the quantity: harvesting, transporting, and peeling take one to two days, soaking and fermenting take three to five days, and washing and pressing to release excess water takes one to two days.

In both villages, a large percentage of processed products are sold compared to the percentage that is consumed or given away. Processing adds value to cassava and the processed products are highly desirable forms that are sold to earn higher income compared to that earned by selling fresh roots. Processing is also needed in order to eliminate the cyanide content of the bitter varieties and make them fit for human consumption. Some farmers also indicated that processing not only adds value, but is also a way of facilitating the consumption and preservation of their huge production and of diversifying their diets, since they cannot depend only on boiled fresh roots for food.

b) Purchased food

While households consume each of the food items that they produce, they also buy food that they do not produce and, in so doing, ensure household food and nutritional security. Farmers talk of buying food for their households as part of their regular costs. A survey of the food items that farmers purchase was not carried out, but a discussion with five Koudandeng women indicated that the most commonly purchased food items include: animal proteins (smoked and fresh fish, pork, and wild game), rice, vegetable oil, bread, tea, tomato, onion, baton, couscous, groundnut, and beigner and muengwalla. According to most women, the purchase of smoked fish (*bifaka*) is common because, while women traditionally fished, this activity is waning compared to fifty years ago since fish numbers in the river have reportedly declined. Koudandeng is located in the rainforest region where, traditionally, wild game hunting and fishing were the main sources of animal protein. Rearing domesticated animals such as pigs, goats, and fowl was and still is uncommon. Bread consumption is considered fashionable, so women often buy bread after selling their crops in Yaounde. Palm nut pulp extract is the main source of oil used in the preparation of kwem (pounded cassava leaves), so imported vegetable oil is purchased by a few Koudandeng households who prepare other dishes that are not eaten with kwem or that require palm oil. Processors sometimes purchase fresh cassava roots to process for sale.

As indicated earlier, beigner is eaten as a snack, especially early in the morning when farmers go to their fields, so that the yards of the few persons who sell beigner are often crowded between 5.00 and 6.30 am. Farmers going to the fields also buy and drink muengwalla to stimulate them to work harder.

In Malende, household food purchases include rice, vegetable oil, animal proteins, plantain, fruit vegetables (okra, tomato), onion, canned tomatoes, fruits, groundnut, maize, gari, and water fufu. Gari, water fufu, and plantain are purchased in small quantities in times of need. While the purchase of raw food items is not very frequent, buying prepared meals is common, especially among men and youths. Farmers go to the fields as early as 5 am and often eat cooked food that is sold by vendors by the roadside and under trees. Upon return from the fields (12 noon to 3 pm), restaurants and food vendors serve as the source of food for members of households that do not have cooked food at home. The traditional dishes that are commonly sold include water fufu and eruh, rice and stew or bean porridge, gari and okra soup, boiled cocoyam tubers or plantain fingers, and soups (vegetable, egusi, stew). Boiled fresh groundnut and maize are purchased during harvest periods.

c) Income generated by food crop sales

Koudandeng households tend to consume a greater proportion of their farm produce compared to Malende households, which sell many crops in larger proportions relative to what is consumed. In Koudandeng, more than half of all maize, sweet potato, tomato, and pepper are sold, while in Malende, households sell over 60% of all cassava, maize, groundnut, egusi, plantain, green, waterleaf, tomato, and okra. Most of the crops that are sold in large quantities are legumes (pulses, green leafy vegetables, okra) and cereals, except for plantain and cassava, which are main sources of carbohydrates (in the case of Malende) that are produced in large quantities that cannot be consumed by individual households.

With respect to the percent of households selling each crop, cassava and egusi and, to a lesser extent, groundnut, maize, and plantain, are major sources of income for Malende households, whereas cassava, groundnut, maize, and, to a lesser extent, plantain and banana, are major sources of income for Koudandeng households. In order of importance, cassava is the most important source of income for households in both villages, where 93.3% and 73.3% of Malende and Koudandeng households, respectively, earn an income compared to the proportion of households that earn income from the other crops.

In Koudandeng, even though cassava is sold in all forms, couscous and baton are the main forms sold, where 86% and 83%, respectively, of total production is sold, whereas only five percent of fresh roots are sold. With respect to the proportion of households involved in the sale of the different cassava forms, cassava fresh roots are more commonly sold (68% of households) followed by baton and couscous, which are sold by fewer than 40% of the households. Only one or two people sell beigner, and eight sell leaves. Farmers either sell one form only or a combination of products. The sale of cassava and cassava products is done mostly either every three or six months.

In Malende, gari and, to a lesser extent, water fufu, are the main cassava forms sold, constituting 92% of total production (Table 6.7). While all of the households that process gari also sell it, not all of the households that process water fufu sell it. Only 26% process and sell water fufu, whereas 13% process it only for home consumption. One household sells fresh cassava roots and two sell standing plants at the farm gate. Two-thirds of all households that sell cassava or cassava products sell gari only, and another 20% sell gari and water fufu only. All ethnic groups sell gari, whereas those households that sell gari and water fufu only belong to four ethnic groups: the Menemo/Moghamo, Bangwa, Bafut and Aghem/Beba/Modele.

To further understand why farmers produce and sell what they produce and which varieties have high value in local markets, the desired characteristics of each cassava form/product and farmer's perceptions of the varieties that meet such characteristics are presented in tables 6.8 and 6.9. The data presented this table show that not all of the HYVs have low value in local markets. The Agric short branching variety in Malende (which is the same as the Irad variety in Koudandeng) produces big and long roots, is easy to process due to its high water content, and produces smooth, soft, shiny, and attractive products.

Table 6.8 Characteristics of the Different Cassava Forms and Varieties Having Such Characteristics - Koudandeng

Cassava Form	*Characteristics*	*Local varieties with such characteristics*	*HYVs with such characteristics*
Leaves	* Attractive: whitish * Do not produce bitter kwem * Easy to pound into kwem	Fonctionnaire, Mbokani, Menyo mbandjock, Muane moung	
Kwem **	* Whitish and shinny colour * Not bitter * Good taste and sweet aroma	Fonctionnaire, Mbokani, Menyo mbandjock, Muane moung	
Fresh Roots	* Good taste and sweet/salty aroma * Appetising: white when boiled * Soft to chew and low/no fibre * Dry and not watery when chewed * Cooks quickly and well * Attractive: red root peel, big and long * Sells quickly and easily * High income/market price * High market demand * Raises volume of processed product	Fonctionnaire, Menyo mbandjock, Apoba moung, Mbokani, Muane moung, Menyo local, Mintole minko, Ikwemi, Mekoughe, Ntangne, Six mois doux, Nkodouma, Sanegai (obala)	Irad (big and long roots only)
Baton (ndeng)	* Gelatinous when cooked * White and shinny (attractive) * Good taste and sweet aroma * Soft and smooth to chew	Fonctionnaire, Menyo mbandjock, Apoba moung, Mbokani, Muane moung, Menyo local, Mintole minko, Mekoughe, ntagne, Six mois amère, Ikwemi (when harvested early)	Irad (in the case of soft and smooth to chew only)
Couscous (vouvou or nkumnkum)	* Gelatinous when cooked * White and shinny (attractive) * Good taste and sweet aroma * Soft and smooth when cooked	Fonctionnaire, Menyo mbandjock, Apoba moung, Mbokani, Muane moung, Menyo local, Mintole minko, Mekoughe, ntagne, Six mois amère, Ikwemi	Irad (in the case of soft and smooth to swallow only)

It therefore has some qualities that are desired by consumers, which explains why it is grown by about 50% of Malende farmers. In Koudandeng, four farmers grew and sold it in the year preceding the survey (2006 - 2007). Each local variety may not have all of the desired characteristics but, compared to the HYVs, they have most of the characteristics that give them higher value in local markets. Generally, the local varieties have a comparative advantage over the HYVs.

Table 6.9 Characteristics of the Different Cassava Forms and Varieties Having Such Characteristics - Malende

Cassava Form	*Characteristics*	*Local varieties with such characteristics*	*HYVs with such characteristics*
Fresh roots	* High dry matter content * Cooks well * Low fibre content * Can be boiled and eaten or pounded into fufu * Big and long * Ease of hand grating * Soaks quickly and easily * Good taste * White colour (appetising) * Good for making gari, water fufu * Do not reduce volume of processed product	Kumba black stick, Kumba white stick, Red skin, Red stick short branching, Old stick, Yaounde	* Agric short branching, Agric tall branching and 20 eye agric have big long roots and are easy to grate and soak easily (in the case of eater fufu processing) * Agric short branching moderately reduces volume of processed product)
Gari	* Shiny * Gelatinous when cooked * Heavy and fills stomach * Light and easy to transport	Kumba black stick, Kumba white stick, Old stick	Agric short branching (except that its gari is not heavy)
Water fufu	* Smooth, soft and less fibre * White and shinny (attractive) * Gelatinous when cooked * Heavy and fills the stomach	Kumba black stick, Kumba white stick, Old stick	

d) Food as gifts: social access to food

Gifts of food to friends and family are an integral part of many cultures that help to make food access more equitable and thus ensure food security among members of a society (Byaruhanga and Opedium, 2008). Gift giving is symbolic and sometimes demonstrates wealth, the success of ceremonies, and the level of generosity of individuals and households. Very often, traditional societies have ways of ensuring the creation and reinforcement of social bonds between individuals and households as well as ensuring that those who have more food share with those who have less. If people go hungry, they have other social means to gain access to food. This is most often done through defined social obligations associated with social rites and rituals (funerals, weddings, religious feasts, births, meetings and reunions), through direct assistance to those who have less, and through the reception of guests. In Malende and Koudandeng, it is normal for people to give away and receive food from other persons, so one of farmers' production objectives is to meet these social obligations. If they are unable to meet such obligations, they may be socially ostracised. What this means precisely is that the giving of food as a social obligation is seen in terms of equity and reciprocity where people create and reinforce their social ties, and those who cannot meet this obligation for one reason or the other (illness, low production) may be regarded as uncooperative and thus may not be assisted by others in time of need. It is possible that this equity and reciprocity principle at times puts some individuals and households under pressure to give away food when they might not have enough themselves, especially during periods when certain types of food are scarce.

Gift giving also has a welfare function, where people who are relatively deprived gain access to food. Food gifts support people who face difficulties for any particular reason. It is a means by which people who cannot meet their social obligations are cared for by other members of the community. The case of Leonie (which I witnessed), a woman who, due to ill health, does not have enough food and thus does not meet her social obligations, is an example. Leonie lost her 32-year old daughter who retails raw food items in an urban market in Yaounde. As a rule in Koudandeng, in times of death and under the leadership of their ward leaders, women contribute various food items and children fetch fuelwood, both of which are given to the deceased's household as assistance to ensure the successful burial of the deceased and to feed the guests who participate in the burial ceremony. Coordinating this assistance in Leonie's case was difficult because she had not been meeting her social obligations. While some women stressed the issue of reciprocity and equity and uncooperativeness, others were concerned about her welfare and illness and therefore persuaded the women to make their contributions. Some women yielded and contributed, and some did not. All of these forms of food redistribution in general help to ensure household food security.

Contributing food during social events is one of farmers' objectives in managing cassava-based polyculture fields. Women prepare and serve food during the performance of traditional, religious/spiritual, and social rites and rituals. Most Malende and Koudandeng women indicated that household food consumption includes not only what is eaten by household members and extended kin, but also what is contributed during such occasions, saying that such food exchanges are indeed significant. This aspect of socialisation is an integral aspect of livelihoods for farming households.

Offering food to guests is also an important aspect of hospitality in the culture. Guests may include: rural development workers such as researchers, extension agents, and NGO workers, and other participants in rituals and ceremonies who are deemed important such as in-laws and their families. Plantain and cereals (Table 6.5), as well as cooked food, are most frequently offered to guests as a sign of welcome. In Malende, gari is most often given away. These are items that are easily transported.

Another important aspect of food redistribution is offering food as gifts to friends, relations and kin, neighbours, and other villagers who either may have less of a particular food item or do not produce it. For example, sending food to adult children and relations who live in urban areas is common. Concubines are also maintained through food giving by both men and women. Apart from pulses, cereals, and staple food items that are shared, some Malende farmers also indicated that they give away rice, palm oil, and animal protein (smoked fish, meat) to friends and relations.

It can be concluded that ensuring physical and social access to food and income generation are three important objectives that must be considered together rather than in isolation when defining agricultural development and food security policies. A neglect of any of these objectives in policies that promote HYVs may either undermine rural livelihoods and food security when HYVs are widely adopted or, as is the generally the case in the study area, households may not accept the HYVs, but instead maintain their traditional foodways and food production systems, which allow them to meet their social obligations, earn an income, and achieve household food security while respecting cultural identity. Koudandeng and Malende households not only have access to food through own production and purchases (physical or material access), but also through redistribution as a means to meet their social obligations.

6.4.2.3 Cassava polyculture systems, agrobiodiversity, dietary diversity, nutritional diversity and insecurity

Here it is argued that the breeding and dissemination of HYVs as a means to increase yield and stability of production to ensure household food security may lead to household nutritional insecurity as a result of the simplification of traditional farming systems and thus of diets. Johns and Eyzaguirre (2006) argue that the simplification of human diets that is associated with increased access to cheap agricultural commodities, together with the erosion of agrobiodiversity that such agricultural homogenisation entails, lead to nutrient deficiencies and excess energy consumption. They hold that large-scale production of cheap agricultural commodities does reduce hunger and increase per capita energy consumption, but it also has adverse effects on dietary quality and it also undermines the food self-sufficiency of small-scale farmers. Here it is argued that Koudandeng and Malende farmers' traditional cassava-based polyculture systems provide nutritionally adequate diets. As discussed in Section 6.4.1.2 above, the combination of a large diversity of crop species and varieties that have different maturation and harvest periods helps to ensure the provision of sufficient food year round. Beyond this, however, the diversity of crops produced and traditional foodways also help to ensure dietary diversity, which means that requirements for macro- and micro-nutrients are also fulfilled. While it was beyond the scope of this research to evaluate the nutritional value of traditional dishes in the study area, Table 6.10 provides the nutritional values of some companion crops that are planted in a cassava-based polyculture system.

As discussed in Chapter 4, a traditional cassava-based polyculture field has on average six to seven different crop species. The composition of these fields, which is determined by farmers' choice of companion crops, is such that the traditional diets obtained provide not only the macro-nutrients but also the micro-nutrients that individuals require for growth and maintenance. For example, a traditional diet that is composed of cassava-based product and vegetable soup will have as main ingredients cassava, cassava leaves, or a green leafy vegetable, egusi or groundnut, palm oil, and an animal protein (depending on the household and the vegetable used). Such a diet is rich in proteins, carbohydrates, dietary fibre, fats and oil, vitamins (A, B-complex, C) and minerals (calcium, potassium, phosphorus, manganese, sulphur, boron, copper, iron and sodium). Other food items that are regularly consumed provide nutrients that are not provided by this diet. Farmers' dietary patterns thus appear to be such that nutrient deficiencies are avoided or reduced to a minimum.

Table 6.10 **Nutritional Values of Some Companion Crops in Cassava Based Polyculture Fields**

Nutritional Element	*Nutritive values per 100g-1 dry weight (% based on USDA recommended calorie diet - 2000 per day)*										
	Cassava		*Ground-nut*	*Egusi*	*Maize*	*Plantain*	*Cocoyam*	*Colocasia (taro)*	*Yam*	*Okra*	*Huckleberry*
	Manihot esculenta Crantz		Arachis hypogaea	Cucumis melo	Zea mays	Musa sapientum	Xanthosoma sagittfolium	Colocasia esculenta	Dioscorea cayenensis/ rotunda	Abelmoschus esculentus	Vaccinium membranaceum
	Fresh roots	*Leaves*									
Energy (cal)	146	131	570	578	363	116		104	105	31	81.2
Carbohydrates: g	34.7 (26%)	11	21	15.7 (8.2%)	71	31.1 (16%)	39%	24.2	24.1	7 (2%)	20.49
Fat/Oil: g	0.3 (1%)	7	48	53.83 (46%)	4.5	0.2		0.2	0.2	0%	0.551
Protein: g	1.2	48.3 (30%)	25	30.3 (28.4%)	10	2	6%	1.9	2.4	2	0.972
Protein (soluble): g				63.94							
Sugars: g	4		0			600%				1	
Dietary fibre: g	2 (15%)	26.9 (39%)	9	4.63 (4.7%)		2.35 (12%)	3			3 (13%)	3.92
Ash: g		6%		3.15 (3.6%)							
Essential minerals (mg)											
Calcium	33 (3%)	1232.4	62 (6%)	129.7	12	59.5	190.93	23	2.2	8%	1%
Iron	0.7 (3%)	9.4	2 (16%)	12	2.5	101 (4%)	1.2	1.1		4%	1%
Phosphorus	128.4	307.1	336 (48%)	755		145.8	44.39				1%
Potassium: mg	890.3	1010.9	332 (7%)	648		500	313.7				129.05
Magnesium	115.3	719.8	184 (50%)				46.7				2%
Sodium	1.14 (1%)	6.64	18	99		4	1365.05				87
Zinc	0.64	5.16	3.3 (33%)				2.49				1%
Manganese: mg	0.12	6.79	1.93								
Copper	0.22	0.73	11.44				0.52				4%
Boron	0.24	6.61									
Sulphur	2.73	271.4									
Nitrogen (soluble)				7.23							

Table 6.10 Nutritional Values of Some Companion Crops in Cassava Based Polyculture Fields (con't.)

Nutritive values per 100g-1 dry weight (% based on USDA recommended calorie diet - 2000 per day)

Nutritional Element	*Cassava*		*Ground-nut*	*Egusi*	*Maize*	*Plantain*	*Cocoyam*	*Colocasia (taro)*	*Yam*	*Okra*	*Huckleberry*
	Manihot esculenta Crantz		Arachis hypogaea	Cucumis melo	Zea mays	Musa sapientum	Xanthosoma sagittfolium	Colocasia esculenta	Dioscorea cayenensis/ rotunda	Abelmoschus esculentus	Vaccinium membranaceum
	Fresh roots	*Leaves*									
Vit. A (iµ. or SI)	trace (1%)	13				35%	trace	trace	trace	7%	3%
Thiamine Vit. B_1	0.06		0.6 (46%)	0.19	0.35		0.1	0.15	0.09		3%
Riboflavin Vit. B_2	0.03		0.3 (20%)	0.15	0.13		0.03	0.03	0.03		4%
Niacin Vit. B_3	0.06		12.9 (86%)	3.6	2		0.8	0.9	0.5		3%
Pantho. acid Vit. B_5			1.8 (36%)								
Vit. B_6			0.3 (23%)	0.09							3%
Folate Vit. B_9			246 (62%)								2%
Vit. C	36 (71%)	120	0	0	0	45%	8	5		35%	31%
Vit. E											3%

Sources: USDA Nutrient Database; Bokanga, 1994; Onopise et al., 1999; Sefa-Dedeh and Agyir-Sackey, 2003; Achu et al., 2005; Chavez et al., 2006; Oladjide, 2006; Oyolu, 2006; Njokou et Obia, 2007.

The importance of dietary constituents and the functional properties of many traditional foods in preventing or lowering the risks of chronic diseases such as prostrate cancer, cataracts, diabetes, and heart disease as well as lowering the rates of morbidity and mortality has been spelt out in the literature (Mares-Perlman et al., 2002; Hasler 2002; Johns and Eyzaguirre, 2006). The genetic diversity presented by traditional cassava-based polyculture fields in Malende and Koudandeng provides nutritionally rich and functionally healthy foods for farming households and consumers as well. For example, a Koudandeng cassava polyculture field in which tomato, green leafy vegetables, and African plum are companion crops will provide lycopene (from tomato and African plum), which prevents prostrate cancer (Hasler, 2002; Johns and Eyzaguirre, 2006) and lutein (from green leafy vegetables), which helps to prevent cataracts (Mares-Perlman et al., 2002; Johns and Eyzaguirre, 2006). An extract from the bark of the African plum called pygeum is used for the treatment of benign prostatic hyperplasia (Cunningham and Mbenkum, 1993; Stewart 2003).

The foregoing analysis rests on the recognition of a clear link between agrobiodiversity, dietary diversity, and nutritional diversity and security. The simplification of production systems implied by the mass dissemination of HYVs and the promotion of monoculture will lead to a reduction in the crop species and dietary diversity that can be obtained from one field, which will have implications for nutrition diversity and security. The decline or reduction in dietary diversity as a result of modernisation or simplification of traditional production systems has been reported in the literature. For example, Byaruhanga and Opedium (2008) noted that, among the Baganda of Uganda, a diversity of unique crops and indigenous practices were used to enrich traditional diets. However, modernisation and commercialisation of crop production led to the loss of indigenous plant diversity and the modernization of diets based increasingly on fewer crops and crop varieties. Pionetti (2006) showed that the commercialisation and adoption of new crop varieties such as chickpea in the Dry Lands of South India resulted in a reduction in the consumption of diverse, nutritionally-rich and functionally-healthy plant foods as a result of the simplification of diets and production systems. As such, farmers' dietary options became limited, which led to micro-nutrient deficiencies. Johns and Eyzaguirre (2006) argue that agricultural technology and the processes of urbanisation, commercialisation, and globalisation have accelerated economic and cultural changes that have led to the erosion of resources and food knowledge in Africa, especially in East Africa. This has exacerbated the problems of under-nutrition, food insecurity, and communicable diseases (including HIV/AIDS and malaria) in Africa.

It can be said that Koudandeng and Malende farmers' traditional cassava-based polyculture systems most likely provide nutritionally adequate diets on a year-round basis. The dietary constituents and the functional properties of the diverse traditional crops in such systems contribute to preventing, or lowering the risks of, chronic diseases and the rates of morbidity and mortality for farming households and consumers. Large-scale monoculture production of HYVs may increase *per capita* energy intake and offer economic benefits for producers as well as reduce costs of food for consumers, but it also has been shown to have mixed impacts on nutritional status (von Braun, 1995) and to reduce traditional dietary diversity (Dewey, 1989; Johns and Eyzaguirre, 2006), which has implications for food and nutrition security and health of small farm households.

Malende and Koudandeng households are not necessarily food insecure. Farmers' strategies to ensure food security for their households include:

- Managing a diversity of food crop fields and crops;
- Consuming a greater proportion of their farm produce;
- Selling surplus production to purchase the food items that they do not produce;
- Redistributing food between households as to meet social obligations;
- Managing many food crop fields as complementary production spaces;
- Orienting their production toward year-round food availability.

The complementarity of food crop fields and crops, the seasonality of production and harvesting patterns of different crop species and varieties, and the relation between food crop diversity and traditional dishes and diets, are important factors in farmers' decision-making that must be considered in food security policies.

6.4.3 Household Income, Sales of Agricultural Produce, and Household Food Security

The main rational behind AGRA's promotion of HYVs is that, "Improved crop varieties should allow farmers to increase yields for consumption or for sale and lead to reductions in the cost of food for all. As improved seeds supplant low-performing varieties, farmers' productivity is increasingly reliable, which in turn creates access to credit and incentives to invest in inputs that include labour." This assumes that farmers' livelihoods depend solely on crop production for consumption and sale and, therefore, their investments should be oriented toward crop production and toward the purchase of agricultural inputs. It neglects the fact that farmers have other livelihood activities in which they invest cash and labour, and that investments in agriculture are likely to compete with investments in other income generating activities. Moreover, farmers and consumers do not accept many cassava HYVs so that, as will be shown, farmers generally earn lower income from sales of such HYVs and their products. Low prices for cassava HYVs means that wider adoption of such HYVs could reduce the earnings that farmers currently generate from cassava sales and thus destabilise livelihoods, especially for women and others who depend mostly on cassava sales for income, which in turn can have negative implications for household food security.

6.4.3.1 Household income sources

Livelihood strategies and options in Koudandeng and Malende are complex and diverse. Households have various sources of income that range from the sale of food crops and processed food products through petty trading including managing beer and provision shops, sales of wild food plants, selling labour for agriculture and food processing, land rental, professional activities (sewing, hair dressing, carpentry, plumbing), salaried employment (nursing, driving), and transfer payments (pensions, remittances) (tables 6.11 and 6.12). The data in Table 6.11 does not include income from cocoa production in Koudandeng because most farmers refused to provide the information since they are afraid that divulging this information might lead to higher tax payments (cocoa is an export crop and must pay taxes to the government on all sales).

The data in Table 6.11 show that, except for pensions and professions such as hair dressing, food milling, beer vending, and salaried jobs (nursing and driving) that provide about 50% or more of total income for 23% of the households, 77% of Koudandeng households derive the largest proportion (51.5%) of their income from agriculture. In the case of Malende, 13% of all cassava-producing households earn over 60% of their income from teaching, clothing sales, or sales of household provisions, and 87% of households depend on agriculture for the majority of their income (> 60%).

In both villages, the households that depend more on agriculture for income are involved either in selling their labour for agriculture or for processing, or in timber/tree felling, buying and selling farm produce, gathering and selling wild plant foods, selling cooked food, or selling own farm produce. A closer examination of the data in tables 6.11 and 6.12 shows that the higher the overall household income, the lower the dependence on sales of own farm produce. In other words, households that earn over 60% of their total income from selling own farm produce fall within the lower income earning household strata. The sale of labour, either for agriculture or for food processing, is an important source of income for lower income households. Gift giving and family remittances are important income sources for lower income earning households in both villages.

6.4.3.2 Income from cassava versus other farm produce and agricultural activities

Livelihoods are complex for all households in Malende and Koudandeng, but most often people depend on land for most of their livelihood activities and household income (tables 6.11 and 6.12).

As discussed earlier in this chapter, households grow and sell a diversity of cereals, pulses, roots and tubers, tree fruits, and perennial and semi-perennial crops and processed products, either as own farm produce or in petty trade/retail (what is known in pidgin English as *buyam-sellam*). Table 6.14 presents data on household income earned by landholding strata. Analysis of the income earned from the sales of these different crops and services in agriculture highlights the fact that, except for tree felling, where the only households in Malende earn high incomes from this activity, cassava remains the most important source of income for all households in both villages. The data in Table 6.14 does not include cocoa, which produces high lump sum payments in Koudandeng, since farmers' refused to report this income for fear of taxes. Cassava is the only crop that is sold in both fresh and processed and cooked forms in local and urban markets, and therefore value added is higher overall.

Even though the income from cassava sales is higher for Malende households compared to Koudandeng households (tables 6.11 and 6.12), Koudandeng households depend more on cassava sales for their incomes. The discussion on food security in Section 6.2.1.2 showed that Malende households produce and sell more cassava (Table 6.4) relative to Koudandeng households (Table 6.5), which may be due to the fact that they manage larger landholdings. However, the gap between the proportions of income earned from selling the different forms of cassava by each strata of landholding is smaller for Malende households compared to Koudandeng households.

Table 6.11 Income Sources for Koudandeng Households by Income Strata

Income Source		*% Income distribution*							
		0 – 186500 fcfa. *N = 9*		*186501 – 500000 fcfa N=9*		*500001 – 1137813 fcfa N = 8*		*1137814– 3313600 fcfa N = 8*	
		% HH	*% total income*	*% HH*	*% total income*	*% HH*	*% total income*	*% HH*	*% total income*
Gifts		44.4	2 - 49	66.7	1 - 6	50	1 – 2	87.5	1 - 2
Family Remittances		33.3	7 – 38	55.6	2 – 67	50	1 – 3	100	1-5*
Pension						12.5	63		
Salary	Driver					12.5	70		
	Nurse			11	53	12.5	55		
Labour sales	Agriculture	22.2	14-80			25	1-3*	37.5	1-3*
	Food processing	22.2	5 - 37	22.2	1 - 2	50	6-20	37.5	1-3
Land rental				11	7				
Profession	Food milling							12.5	49
	Basket weaving					12.5	1		
	Carpentry					12.5	12		
	Plumbing							12.5	4
	Traditional Healer			11	3				
	Event Animation							12.5	4
	Sewing/Tailoring							25	17
	Chair making							12.5	1
	Hair dressing			11	81	12.5	47		
Chair rental						12.5	21		
Beer vending (bar)				11	70	12.5	20	12.5	29
Household provision vending								12.5	20
Petty trading food stuff	Palm oil			11	33	12.5	16	12.5	30
	Groundnut	11	39						
	Yam							25	13-80
Wild plant food sales	njangsa					12.5	1	25	1
	eruh					12.5	1	12.5	0.8
Cooked food sales	Puff balls	11	74			12.5	15	25	51-55
	Wild game					12.5	12		
	Yogurt							12.5	7
Own farm produce		100	10-100	100	17- 99	100	25-100	100	16-78

Source: Household and Cassava Production Survey

Table 6.12 Income Sources for Malende Households by Income Strata

Income Source		*% Income by Income Strata*							
		0 – 412500 fcfa N = 9		*412501–930000 fcfa N = 7*		*930001-1488875 fcfa N = 7*		*1488875–9052000 fcfa N = 7*	
		%HH	*% total income*	*% HH*	*% total income*	*% HH*	*% total income*	*% HH*	*% total income*
Gift		22	25	14	25	71	2	57	1.5
Family Remittances		33	15	14	5	14	1	14	6
Labour Sales	Crop manage-	11	71	14	25.5	57	30		
	Food processing	22	13	14	19	28.6	43	28.6	0.4
Salary	Electricity com-	11	39						
	Teaching					28.6	52		
Land rental		11	19	14	20			28.6	7
Push truck rental						14	22		
Professional	Carpentry					14	9	14	3
	Land Sales							14	18
	Transport (mo-			14	34				
	Timber/tree							14	65
	Sand selling	11	25			14	5		
	Clothes vending							14	66
Petty trading	Palm nuts					14	6		
	Palm oil							14	1
	Palm wine							14	69
	Rice (raw)			14	16				
Household provision vending								14	79
Selling Cooked food	Water fufu					14	6		
	Rice					14	7		
	Wild game			14	26				
	Assorted food					14	11	14	7
	Puff-puff (puff			28.6	79				
Own farm produce		100	71	100	63.4	100	54	100	49

Source: Household and Cassava Production survey.

Land is therefore a key resource in both villages. Landholding sizes are varied and range from 0.2 ha to 22 ha in Koudandeng, and from 2 ha to 13.1 ha in Malende. On the basis of total landholdings managed per household, four categories of households were identified for each village (Table 6.13). In general, 55% of all households in both villages manage landholdings less than or equal to four ha. However, as shown in the table, the sizes of land-holdings differ by village, where Malende households generally manage larger land holdings relative to Koudandeng households. Only three of the 34 Koudandeng households studied managed above 13 ha of land.

Irrespective of the size of landholdings, the sale of labour for cassava production and processing is common among all households. Observations during field work indicated that the sale of labour for cassava processing is more apparent in Malende (especially for gari production) compared to Koudandeng because, in Malende, processing must be concentrated in a short period of time (processed cassava products are highly perishable) since markets in Malende and neighbouring villages are held only weekly, whereas Koudandeng farmers sell their produce in the daily urban markets of Yaounde and Obala.

Table 6.13 Size of Landholdings Managed by Households

Koudandeng		*Malende*	
Landholding range (ha)	*% Households managing*	*Landholding range (ha)*	*% Households managing*
0 – 1.45	29.4	0 - 4	33.3
1.45 – 3.51	20.6	4.1 - 5	26.7
3.52 – 8.5	32.4	5.1 - 8	20
8.51 - 22	17.6	8 – 13.05	20

Source: Cassava Survey 2007.

6.4.3.3 Income from cassava HYVs versus local varieties

Farmers' local cassava varieties obtain higher income relative to HYVs (tables 6.15 and 6.16). The discussions on farmers' perceptions of their cassava varieties in Section 5.5.3 of Chapter 5 showed that the marketability of cassava varieties depends on a number of factors, such as their suitability for making specific processed products, processing qualities, attractiveness, and palatability. Although no variety possesses all of these qualities, the HYVs were generally perceived to least fulfil these criteria compared to local varieties. Most farmers consider that the high water content of HYVs make them less suitable for processing since it reduces the final volume of processed products. It was beyond the scope of the study to measure the actual volume of products processed from HYVs and local varieties, so this requires further research. In Malende, it is considered that HYVs produce lightweight products that do not fill the stomach. As well, in Koudandeng, the roots are not considered to be attractive. These varieties are perceived to have lower market demand (see below) and income from their sales appears to be lower compared to local varieties. Results of the cassava survey show that 54.5% of Malende households involved with processing and sales of HYVs reported that, even though they earn a reasonable income from HYVs, large quantities of roots are needed to produce small volumes of gari and water fufu compared to the quantity of local varieties required. Farmers said, "Agric varieties shrink gari and water fufu, but Kumba black stick and Kumba white stick raise paste and produce heavy gari and water fufu."

Nevertheless, some Koudandeng farmers said that the high water content of HYVs makes them suitable for processing into specific products; processing is easier and produces a soft and smooth paste, which improves the quality. Nevertheless, at the time of this research (2007), only one Koudandeng farmer actually cultivated an HYV, and then only one variety: Irad, or Agric short branching. Malende farmers said that the HYVs give a soft, smooth texture and shiny colour when processed into water fufu. The discussions related to the desirable qualities of cassava and cassava products presented in Table 6.8 above show that the Agric short branching (Irad) has some qualities that consumers desire, which explains why it is grown by about half of Malende's cassava farmers.

Farmers who manage small landholdings in Koudandeng do not perceive that the HYVs are as valuable for generating income whereas, in Malende, mostly farmers from households that manage between four and five ha (medium farms) perceive HYVs as valuable for this purpose, which helps to explain why these varieties have overall low acceptance and use. The data collected on household income was based on the previous year since, at the time of the research, cassava that was grown in 2007 had not yet been harvested. This analysis showed that four and five households in Koudandeng and Malende, respectively, grew and sold HYV cassava varieties in 2006. No household managing less than 1.45 ha of land produced or sold HYVs in Koudandeng. The discussion in Section 5.6 of Chapter 5 on factors influencing varietal diversity (Table 5.18) showed that 55% and 31% of Malende households grew the Agric short branching and Agric tall branching varieties, respectively, in 2007. Further discussions about the frequency of occurrence of varietal clusters in farmers' fields showed a statistically significant X^2 frequency value at the .001 level (Table 5.19).

Despite the fact that, in 2006, cassava HYVs were grown by four households in Koudandeng and 54.5% of cassava producing households in Malende, the data in tables 6.15 and 6.16 show that, in general, cassava HYVs sales result in lower income compared to local varieties in both villages (about nine percent of total household income in both villages). However, the analysis of income from cassava shows that, for those Koudandeng households that manage both HYVs and local varieties, the HYVs generated less total income than the local varieties (Table 6.14) but, in such households in Malende, they generated at least a third of total income from cassava sales. This may be due to the fact that Malende households develop strategies that facilitate the sales of HYV cassava products. These strategies include: a) processing more HYVs during the period of peak farm activities when processed cassava products are scarce and consumers are willing to pay for any product, irrespective of the quality; b) processing more HYVs into water fufu than gari because of the soft and smooth consistency needed for water fufu; c) some 23% of Malende households mix HYVs and local varieties before processing into gari, and two farmers said that, in such mixtures, HYVs make up 30% and local varieties 70% of the total volume processed, which reduces the effect of the HYVs on the final product. Nearly a quarter of all cassava farmers reported that they mix both local and HYVs before processing, and by this means obtain reasonable volumes of processed products each time they process; and d) some Malende farmers indicated that they sell HYVs as standing plants in the fields, thus saving time in processing that is insufficiently remunerated compared with the time spent processing local varieties, given the higher income received for the same quantity of processed fresh roots.

Despite the lower unit income received from HYV sales, interviews with two prominent HYV growers (Verma and Thaddeus) indicated that these varieties have quicker turnover rates since they are early maturing. Two crops of HYVs can be harvested in less than two years, which increases the volume of sales and generates higher levels of income. In Malende, the HYVs mature between eight and nine months after planting, while the local varieties mature from between 18 and 24 months after planting.

Table 6.14 Income Sources from Cassava Versus Other Crops and Agricultural Activities

Income source			*Household Landholding Categories*															
			Koudandeng								*Malende*							
			0-1.45 ha		*1.451-3.5 ha*		*3.51-8.5 ha*		*8.51-22 ha*		*0-4 ha*		*4.1-5 ha*		*5.1-8 ha*		*8.1-13 ha*	
			N = 10		*N = 7*		*N=11*		*N=6*		*N=10*		*N=8*		*N=6*		*N=6*	
			% HH	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*
Root	1. Cassava		90	30	100	52.4	73	44	100	42	100	28	87.5	36	66.7	38	83	33
and		Roots	80	20	85.7	32.5	63.6	32	100	31	10	15	37.5	28	16.7	88	66.7	30
tuber		Baton	40	12	28.6	26.5	36.4	18.3	33.3	26							83	28
crops		Couscous	40	18	42.9	20	36.4	8	50	8							16.7	50
		Leaves	10	14	42.9	18.6	36.4	8	16.5	0.9								
		Gari									90	32	75	35	50	33		
	Water fufu	Raw									10	6	25	22	16.7	7		
		Cooked									10	26						
	Labour	Weeding	10	2	42.9	10	9	1	33.3	32	20	9.5	12.5	15	50	29	16.7	34
		Processing	40	16.8			51	22			50	10			33	20		
	2. Sweet potato		20	3.5	14	2	18	10										
	3. Yam		30	9	28.6	11	18	2	16.5	3			12.5	11			16.7	29
	4. Cocoyam		10	1					16.5	6	30	7					66.7	4.3
Perennial and	1. Palm wine		30	39			27.2	8	50	48								
semi-perennial	2. Palm nuts		10	10			18	5										
crops	3. Palm oil								16.5	4			12.5	1	16.7	25		
	4. Fruits: pear mango, plum		10	16	28.6	17	18	20									16.7	1
	Fruit: orange, pineapple												25	42	16.7	3		
	Cocoa												12.5	22	33	30	16.67	4
	Plantain		20	4	28.6	11	54.5	23	16.5	9	10	1	12.5	7	50	5	66.7	12.5
	Banana		30	37.5	42.8	9	45.5	28	66.7	3.5								

Table 6.14 Income Sources from Cassava Versus Other Crops and Agricultural Activities (con't.)

Income source		*Household Landholding Categories*															
		Koudandeng								*Malende*							
		0-1.45 ha		*1.451-3.5 ha*		*3.51-8.5 ha*		*8.51-22 ha*		*0-4 ha*		*4.1-5 ha*		*5.1-8 ha*		*8.1-13 ha*	
		N = 10		*N = 7*		*N=11*		*N=6*		*N=10*		*N=8*		*N=6*		*N=6*	
		% HH	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*	*% HH*	*% Ag*
Petty trade	Palm oil	20	24					16.5	38			12.5	2				
	Palm nuts													16.7	5		
	Palm wine					9	58			10	67						
	Groundnut	10	80														
	Yam					18	52										
	Rice (raw)											12.5	9				
Wild plant foods: eruh, njangsa						18	2	16.5	1.5								
Cooked food	Rice									10	8						
	Assorted food													33	7		
	Wild game									10	16						

Sources: Household and cassava surveys.

Table 6.15 Proportion of Income from HYVs versus Local Cassava Varieties for Koudandeng Households

Var. Type	Form Sold	% Income by Landholding Strata								% Total inc. from cassava	% Total HH (N=34)
		0 – 1.45 ha (N=10)		1.451 – 3.51 ha (N=7)		3.52 – 8.5 ha (N=11)		8.5 – 22 ha (N=6)			
		% inc.	% HHs	% inc.	% HHs	% inc.	% HHs	% inc.	% HHs		
HYVs	Leaves									0.0	0.0
	Roots			1	14.2			1	16.7	1	8.8
	Baton					21.5	27.3			7.8	8.8
	Couscous									0.0	0.0
Local varieties	Leaves	11.7	10	13.2	42.8	10.4	36.4	0.09	16.7	7.5	26.5
	Roots	54	80	65.6	85.7	51.1	63.6	56.9	100	56.1	79.4
	Baton	11.9	40	4.2	28.6	6	27.3	24.1	33.3	12.1	32.4
	Couscous	22.4	40	16	42.8	11	36.4	17.9	50	15.5	41.2

Source: Cassava Survey 2007.

Table 6.16 Proportion of Income from HYVs versus Local Cassava Varieties for Malende Households

Var. Type	Form Sold	% Income by Landholding Strata								% Total inc. from cassava	% Total HH (N=30)
		0 – 4 ha (N = 10)		4.1 – 5 ha (N=8)		5.1 – 8 ha (N=6)		8.1 – 13 ha (N=6)			
		% inc.	% HHs	% inc.	% HHs	% inc.	% HHs	% inc.	% HHs		
HYVs	Leaves										
	Roots			1.7	12.5					0.3	3.3
	Gari	3.4	20	20	12.5			3	16.7	5	13.3
	Water fufu			21	25	2.4	16.7	1	16.7	3.7	13.3
Local	Leaves										
	Roots	5.1	10	17	37.5	12.7	16.7	13.2	66.7	8.7	30
	Gari	91.2	80	32	50	65.5	50	93	66.7	80.7	60
	Water fufu	1.6	20	0.6	25					0.5	10
HYV + Local	Gari	5.6	40	8	25	19.4	16.7			5.9	23.3

Source: Cassava Survey 2007.

Table 6.17 shows that, for Koudandeng, no matter what forms are sold, HYV based products sell at lower unit prices compared to those produced with local varieties. The prices of the different cassava forms vary according to season, and farmers sometimes adjust local unit measures, especially for products made from local varieties, in order to earn higher income. For example, during periods of relative scarcity (the dry season, when the ground is dry and cassava harvesting is difficult), the size of baton sticks produced from local varieties is smaller compared to those made from HYVs. Three major processors and sellers of baton reported that most consumers in Yaounde and Obala taste baton to determine its quality before buying. These consumers pay high prices for those baton sticks that are processed from local varieties since they are considered to have good taste and aroma even if they are smaller than those made from HYVs and other local varieties that do not have such qualities.

In Koudandeng, it is considered that HYVs are not good for making couscous because of low dry matter content. Farmers sell leaves from specific local cassava varieties that do not produce bitter kwem, such as Mbokani, Fonctionnaire, Menyo mbandjock, Menyo local, Ikwemi, and Muane moung. The leaves of most bitter varieties (including HYVs) are not sold because they produce bitter kwem. In relation to the total production sold in Koudandeng, local varieties have a distinct advantage over HYVs since the leaves can be sold. Cassava leaves are not eaten in the Southwest Province to which Malende belongs, and so are not sold by Malende farmers. The discussions in Section 6.2 above pointed out that local foodways determine what farmers produce and sell.

Table 6.18 shows, in contrast, that the prices of the different cassava forms do not differ much for HYVs and local varieties in the three cassava markets used by Malende households. The fact that HYVs are watery, which reduces the volume of processed products, means that farmers earn lower total income from HYVs compared to the income earned from local varieties. Malende farmers thus use the various strategies mentioned above to earn reasonable incomes from HYVs.

Table 6.17 Prices of HYVs Versus Local Varieties in Local Markets for Koudandeng Households

Market	*Price per unit product (fcfa)*							
	HYVs				*Local varieties*			
	Leaves (1.5 kg)	*Roots (100 kg)*	*Baton (3 sticks)*	*Couscous (15 kg)*	*Leaves (1.5 kg)*	*Roots (100 kg)*	*Baton (3 sticks)*	*Couscous (15 kg)*
Yaounde: * Etoudi	-	-	100	-	250 - 300	2000-2500	300	3500
* Mfoundi	-	1700-2000	-	-	200 - 250	2000	150-225	3000
* Elig Edjoa	-	-	100	-	200	2000	150-225	3000
* Etoi Meki	-	-	-	-	150		150	2700
Koudandeng	-	2000	50	-	-	-	75	1750
Kousseri	-	-	300	-	-	-	-	-

Source: Cassava survey 2007.

As discussed in Section 6.2 above, farmers' general livelihood goals in crop production are to ensure income generation, meet social obligations, ensure household food supply, and fulfil local food traditions. In relation to cassava, farmers act rationally by accepting those varieties that have the desired qualities that help to fulfil these goals. Some HYVs and local varieties are accepted while others are rejected. No variety exhibits all of the desired qualities, so farmers manage many varieties. The qualities of one variety complement the qualities that are lacking in another. For example, the Agric short branching variety or Irad, which is an HYV, has the following qualities: produces soft, smooth and shiny baton and water fufu and lightweight gari that is easy to transport for sale in distant markets, is high yielding and early maturing, and thus has rapid turnover for farmers in Malende. These qualities complement some local varieties that are fibrous and thus may not produce soft and smooth processed products or that are late maturing but have other qualities such as increasing the volume of processed products, having good taste and aroma, and are attractive and thus are in high demand with higher prices. The discussions about farmers' perceptions of cassava varieties in Chapter 5 highlighted the fact that HYVs are not higher yielding than some local varieties such as Red skin, Kumba black stick, and Kumba white stick, in the case of Malende, and Fonctionnaire, Mbokani, Mintole minko, Ikwemi, Muane moung, Sanegai, and Menyo mbandjock in the case of Koudandeng (see tables 6.15 and 6.16).

Table 6.18 Prices of HYVs Versus Local Varieties in Local Markets for Malende Households

Market	*Price per unit product (fcfa)*					
	HYV varieties			*Local varieties*		
	Roots 1 truck = 250kg	*Water fufu 1 bag = 50kg*	*Gari 1 basin = 50kg*	*Roots 1 truck = 250kg*	*Water fufu 1 bag = 50kg*	*Gari 1 basin = 50kg*
Malende	36000	9000	9500*	36000	9500*	8000-9000
Yoke		7000-8000	6500		8000*	7000-8000
Muyuka			9500*			9000-10000

Source: Cassava survey 2007.

The data in tables 6.16 and 6.17 above show that fresh root sales generate lower income than the sale of processed products. Even though fresh roots cost less to produce compared with processed products given the labour that is devoted to processing and the opportunity cost associated with other activities, farmers are compensated by the value added in processed products and thus diversify their income by selling both processed and unprocessed products.

6.4.3.4 Implications of the prices of HYVs and income for livelihoods and food security

The discussions in this section highlight the fact that farmers act rationally in terms of ensuring food security and income generation by accepting some HYVs, but not all. Varieties that have the desired characteristics are accepted and, since no variety has all of the desired qualities, farmers manage a diversity of varieties, including some HYVs. Here it is argued that, while HYVs are useful, if they were to displace local varieties, the economic implications for households could be severe. While the HYVs have some benefits, such as enabling rapid turnover due to early maturation and relatively high yields, producing smooth, soft, and shiny processed products and providing income at certain periods of the year, the implications of more widespread acceptance for household income and food security are greater. For example, the discussion on yield in Chapter 4 showed that farmers report that the HYV planting material produces high yields only when replanted for less than three successive years or crop seasons, after which high yields can only be maintained with the use of fertilisers. Further discussions on the use or non-use of fertilisers indicated that 10% of Malende farmers use fertiliser mainly on HYVs (the implications of increased fertiliser use for agroecology are discussed thoroughly in Chapter 4). The two male farmers who cultivate HYVs in monoculture spent between 125000 fcfa and 150.000 fcfa (US$ 208 to US$ 250) on NPK fertiliser per field. The cost of 20:10:10 NPK fertilisers ranges between 2.1% and 3.8% of total input costs (fertiliser and labour). The cost of HYV production is therefore higher compared to local varieties, which do not require fertilisers. Widespread acceptance of HYVs will increase fertiliser use and therefore household expenditures on agriculture. Apart from the high costs of inputs, AGRA also recommends that soils should be tested before applying fertilisers, which entails additional costs for households (see Chapter 4). This may have implications for food purchases, children's education, family health care services, clothing, and meeting social obligations. High investment in agricultural inputs will compete with investments in other income generating activities.

If HYV yields actually increase with the use of fertilisers, then the demand for labour for production, processing, and sales will increase, and farmers will either shift labour devoted to other income generation activities to cassava, or will have to use hired labour. This implies either another trade off with respect to other livelihood activities (the opportunity cost of this labour), or higher total input costs for cassava production, or both. HYVs already have a clear price compared with local varieties; substantially increasing cassava production is likely to lead to saturated markets, which will lead to a decrease in cassava prices. Farmers may thus confront the classic contradictions of agricultural markets (overproduction) that give rise to agricultural subsidies in developed countries, but not in developing countries, which are too poor to pay such subsidies. In terms of labour, the burden on women as the main processors and marketers of cassava and providers of food for their households will increase with large-scale cassava production. In order to obtain higher prices, cassava needs to be processed; the pressure to process could increase if cassava prices decrease. Women would have to process a greater volume of products to earn the same amount of income.

The conclusions are that, even though HYVs are useful for farmers, their widespread adoption could destabilise livelihoods, especially for women and those farmers who depend mostly on cassava for income, which could have negative implications for food security since income from cassava is used to purchase the food items and high protein foods that farmers do not produce. If AGRA and the Cameroon Government's recommendations are followed, production costs may increase whereas prices may not compensate the higher costs. Other household expenditures might also be negatively affected, e.g. for children's education, family health care, contributions and savings in social groups and to events in the community (marriages, deaths, baptisms etc.).

Livelihoods are complex for all households in Malende and Koudandeng, but most often people depend on land for most of their livelihood activities and household income. Large-scale production of cassava HYVs may lead to land scarcity and therefore competition and conflicts over land between and within households. Households that manage small landholdings (especially those in Koudandeng that manage less than 1.5 ha) who do not see HYVs as a valuable source of income and therefore do not grow them would be most negatively affected. Cassava roots and couscous are the most important sources of income for these households and HYVs do not have the qualities that such farmers desire.

6.5 Conclusions

The conclusions below are written in relation to each hypothesis to facilitate analysis and understanding of the issues surrounding the release of HYVs and the implications for food and nutritional diversity and security as well as livelihoods in small-scale traditional polyculture systems in Sub-Saharan Africa.

Hypothesis 1

Traditional cassava polyculture systems are managed so that the crop combinations and the temporal distribution of crops meet farmers' multiple needs and interests.

Contrary to the assumption made by AGRA, the Cameroon Government, and research institutions that farmers grow crops mainly for food and income, this study's findings indicate that Koudandeng and Malende households' polyculture systems and choices of crop types and varieties are determined by a wider number of factors. These factors, which are entwined in a complex web of livelihood strategies, include: nutritional, economic, socio-cultural, spiritual, and health needs and interests, and labour and land constraints. Policies that emphasise only smallholder's food and income needs may function in detriment to other socio-cultural, spiritual, and health values that farmers attach to their varieties and cropping systems, which also inform how they perceive and relate to the natural, social, and spiritual worlds. Such policies may have negative implications for food security and farmers' and farm households' well being and livelihoods if farmers accept the HYVs and production systems that AGRA and others promote. Biological, socio-cultural, economic, spiritual, and health factors that shape farmers' decision-making frameworks determine which cassava varieties they manage, and should be considered as a whole rather than in isolation when formulating food security and agricultural policies.

Hypothesis 2

It is farmers' own food choices and preferences and those of other local populations that determine which crops to grow and sell in local markets.

The findings of this study are used to contest AGRA's assumption that African farmers' local cultivars do not produce high yields and therefore harvests are not reliable, making most households food insecure, and therefore the release of HYVs will lead to more abundant and reliable harvests. It has been shown that Koudandeng and Malende households are not necessarily food insecure and that their strategies for ensuring household food and nutritional security are determined by local foodways, which in turn influence their farming systems and crop diversity. These strategies include: i) managing a diversity of food crop fields and crops; ii) consuming a greater proportion of their farm produce; iii) selling surplus production to purchase the food items that they do not produce; iv) redistributing food between households to meet social obligations; v) managing many food crop fields as complementary production and consumption spaces; and vi) orienting their production toward year-round food availability.

Making global assumptions that African households are food insecure due to low and unstable crop yields obviates the fact that most African traditional farming systems are polycultures that are managed to ensure year-round food availability, thereby providing food security for households. The complementarity of food crop fields and crops, the seasonality of production and patterns of harvesting of individual crops and crop varieties, and the relation between food crop diversity and traditional dishes and diets, are important factors in farmers' crop and varietal selection decision making that must be considered in food security and agricultural policies that must be considered as a whole rather than in isolation. Breeding and disseminating HYVs to increase yield and income may lead to shifts in traditional farming systems from subsistence-oriented polycultures to commercially-oriented monocultures, and therefore the interconnections between these factors will be broken. Market forces may eliminate the complementarity and seasonality of crop production and consumption, which may lead to greater food insecurity since dietary options are reduced and diets themselves may be greatly simplified. Households will be more dependent on food purchases, which further increases the risk of food insecurity, especially when the ability to purchase food or inputs, or the ability to sell at a profit, become limiting factors.

The local foodways of Koudandeng and Malende peoples determine the crops that are grown and sold in local markets. Farmers' traditional polyculture systems and choice of crops is in part based on local foodways, and they plant a combination of crops to meet their food traditions and needs for dietary diversity, consuming dishes that are constituted of various combinations of these crops and wild food plants. New crop varieties that are bred to increase yields may not fit with farmers' foodways, which may lead to food and nutrition insecurity as well as cultural and genetic erosion.

Farmers appear to be maintaining many of their traditional ways of life and have been persuaded to accept cassava HYVs on a very limited basis, without making the major changes to their farming systems that would be implied by mass adoption. Farmers and consumers have traditions that have served them well over time. They have developed and adapted cassava varieties to their agroecological conditions and their ways of life. Even when farmers migrate, they maintain their traditional dietary patterns, which creates a sense of feeling at home away from home and helps them to maintain their cultural identity, which also contributes to the maintenance and diffusion of agrobiodiversity.

Cassava and cassava products occupy a central place in traditional diets, especially among the people for whom cassava is the main staple. The acceptability of local varieties and HYVs depends on the meaningfulness of each variety to farmers, which is determined in part on their suitability for making various traditional products that are part of traditional foodways, which largely explains why 28 and 16 varieties are managed in Koudandeng and Malende. These varieties in turn help to ensure food security for households since a greater proportion of the products are consumed daily, year-in-year-out. However, different cassava varieties have different combinations of characteristics and, since no 'ideal' variety exists, farmers maintain a range of varieties that have specific traits that meet their goals.

Except for some of the processing qualities (such as producing soft, smooth, and shiny processed products) that some HYVs have, generally speaking HYVs do not have most of the qualities that farmers and consumers desire. The widescale acceptance of HYVs that the Government of Cameroon has promoted since 1986, or nearly 25 years, has been largely unsuccessful in the study areas, which are located in Cameroon's 'cassava belt'. The reasons for this lack of acceptance are not recognised by the Cameroon Government, AGRA, or the international and national research institutions concerned with the promotion of a green revolution in Africa. Two scenarios are possible for the future: widespread HYV acceptance could destroy these traditional polycultures, foodways, and ways of life, or farmers may continue to only adopt those HYVs that fit well within their agricultural systems, meet their farming objectives, and fulfil culinary, social, and cultural traditions.

Hypothesis 3

Cassava farmers from Koudandeng and Malende do not confront problems with food security and malnutrition since they grow most of the food that their households need in their traditional intercropped fields.

AGRA's use of cereals as reference crops to evaluate crop production in traditional farming systems and therefore households' level of food security obviates the fact that cereals are not staple crops for many African communities and their production will be low in regions where roots and tubers and other crops are staples.

Cassava and cassava products play an important role in farmers' strategies for ensuring food security in both villages. Cassava is eaten in at least five different forms, which diversifies households' diets. Households are not desperate and are able to produce not only what they consume but also to process and sell surpluses to obtain higher incomes, which enables them to purchase high protein foods and other food items that they do not produce. Processing adds value to cassava and local consumers prefer such traditional products, which helps to maintain the strong links between consumers and farmers. Cassava and its products constitute local indigenous varietal foods that are adapted to the local environment, and people who do not have access to these local diverse foods through own production support farmers through purchase. Cassava constitutes the most important source of income for farming households. The income earned from cassava also enables individuals make contributions to their social and financial groups and to meet other social obligations.

Koudandeng and Malende households not only have access to food through own production and purchase, but also through redistribution through gift giving among kin and neighbours. Appropriate agricultural development and food security policies must strive to enable rural households to meet their objectives of ensuring food security, which includes both physical and social access to food, and livelihoods. Policies that emphasise food markets underestimate or ignore the function of social access to food which is an integral part of most rural African communities, where traditions and customs enable the redistribution of food to those who have less and the creation and reinforcement of social bonds or ties.

Major goals of rural households are to provide physical and social access to food and income generation in accordance with local cultural norms and practices, which must be considered together rather than in isolation when defining agricultural development and food security policies. A neglect of any of these functions in policies that promote HYVs may either undermine rural livelihoods and food security when HYVs are widely accepted or, as is the generally the case in the study area, households may not accept the HYVs, but instead maintain their traditional foodways and food production systems, especially to maintain their cultural identity, meet their social obligations, earn an income, and achieve household food security.

Hypothesis 4

Traditional cassava polycultural systems provide a nutritionally adequate diet.

The results presented above indicate that farmers' traditional cassava-based polyculture systems most likely provide nutritionally adequate diets on a year-round basis, and are thus crucial to providing food security for households. Farmers manage their traditional polyculture fields to ensure food self-sufficiency and security for their households, and any alterations in these farming systems may lead to their simplification or, at the extreme, to commercial monoculture, leading to a sharp reduction in crop diversity and the corresponding dietary diversity that can be obtained from one field. The consequences are a change in local dietary patterns, which may have negative consequences for nutrition diversity and security, and food self-sufficiency and security.

Traditional polyculture systems, crop and varietal diversity, and foodways are intimately related, and a clear link exists between agrobiodiversity, dietary diversity, and nutritional diversity and security. The genetic diversity presented by traditional cassava-based polyculture fields in Malende and Koudandeng provides nutritionally rich and functionally healthy foods for farm households and consumers as well. The composition of these fields, which is determined by farmers' choice of companion crop species and varieties, is such that the traditional diets obtained provide not only the macro-nutrients, but also the micro-nutrients that individuals require for growth and maintenance. Farmers' traditional dietary patterns appear to be such that nutrient deficiencies are avoided or reduced to a minimum.

The dietary constituents and the functional properties of the diverse traditional crops in traditional polyculture systems contribute to the prevention or lowering of the risks of chronic diseases (such as prostrate cancer, cataracts, diabetes, and heart disease, HIV/AIDS and malaria) and the rates of morbidity and mortality for farming households and consumers. Large-scale monoculture production of HYVs may increase *per capita* energy intake and offer economic benefits for producers as well as reduce costs of food for rural and urban consumers, but it reduces dietary diversity and may have mixed impacts on nutritional status and therefore exacerbate rather than solve or reduce the problems of under-nutrition, food insecurity and non-communicable and communicable (HIV/AIDS) diseases.

Hypothesis 5

Livelihood strategies and options in Koudandeng and Malende are complex and diverse and, in their pursuit of these strategies and options, households' cash and labour investments are competitive for each livelihood activity. The low acceptance of HYVs among farmers and consumers alike implies that total income from HYVs may be low, and therefore wider acceptances of HYVs could reduce the earnings that farmers currently generate from cassava sales and destabilise livelihoods, especially for women and for those farmers who depend mostly on cassava for income, which in turn will have negative implications for household food security.

The findings presented here contest AGRA's assumption that, as improved seeds supplant low-performing varieties, production will be increasingly reliable, which in turn creates access to credit and incentives to invest in inputs including labour. Thus, it is assumed that farmers' livelihoods depend solely on crop production and, therefore, their investments will be oriented toward increasing crop production through the purchase of agricultural inputs. Findings show that farmers and their households have other livelihood activities in which they invest cash and labour, and high investments in inputs and labour for cassava production are likely to compete with investments in other income-generating activities, while at the same time, increased production of cassava HYVs may lead to reduced income.

Farmers' general livelihood goals in crop production are to ensure adequate income generation (without seeking profit maximisation), meet social obligations, ensure household food supply, and fulfil local food traditions. In relation to cassava, farmers act rationally by accepting those varieties that have the desired qualities that help to fulfil these goals. Since no variety actually exhibits all of the desired qualities, farmers manage a diversity of varieties, including some HYVs. While HYVs have some benefits, such as enabling rapid turnover due to early maturation and relatively high yields, producing certain smooth, soft, and shiny processed products and providing income during certain periods of the year, they generally have low acceptance among farmers and consumers so that farmers generally earn lower income from sales of cassava HYVs and their products. More widespread acceptance of such HYVs could reduce the earnings that farmers currently generate from cassava sales and therefore the implications for household income and food security are great. If HYVs were to displace local varieties in local markets, the economic implications for households could be devastating, which could destabilise livelihoods, especially for women and those farmers who depend mostly on cassava for income. This could have negative implications for food security since income from cassava is used to purchase the food items and high protein foods that farmers do not produce.

The cost of HYV production is higher in terms of external inputs compared to local varieties, which do not require fertilisers, and therefore their widespread acceptance would increase the amount of investment that must be made to procure fertilisers and planting materials, and therefore overall household expenditures. Apart from the high costs of inputs, AGRA also recommends that soils should be tested before applying fertilisers, which entails additional costs for households. If AGRA and the Cameroon Government's recommendations are followed, production costs will increase whereas prices may not compensate. Other household expenditures might also be negatively affected, e.g. for children's education, family health care, contributions and savings in social groups and to events in the community (marriages, deaths, baptisms etc.).

Increased yields of HYVs will increase the demand for labour for production, processing, and sales, and farmers will either have to shift labour devoted to other income generation activities to cassava, or they will have to pay for more hired labour. This implies another trade off with respect to other livelihood activities (the opportunity cost of this labour). In terms of labour, the burden on women as the main processors and marketers of cassava and providers of food for their households will increase. In order to obtain higher prices, cassava needs to be processed; the pressure to do so could increase if prices for cassava decrease. Women would have to process a greater volume of products to earn sufficient income. Increased production of cassava is likely lead to saturated markets and therefore a decrease in cassava prices. Farmers may thus confront the classic contradictions of agricultural markets (over-production) that give rise to agricultural subsidies in developed countries, but not in developing countries, which cannot afford subsidies.

Livelihoods are complex for all households in Malende and Koudandeng, but most often people depend on land for most of their livelihood activities and household income. Large-scale production of HYVs may lead to land scarcity and therefore competition and conflicts over land between and within households. Households that manage small landholdings (especially those of Koudandeng that manage less than 1.5 ha) who do not see HYVs as a valuable source of income and therefore do not grow it would be most negatively affected. Cassava roots and couscous are the most important sources of income for these households and HYVs do not have the qualities that farmers desire.

CHAPTER SEVEN
CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

In an attempt to understand the implications of policies that promote Green Revolution-type technologies and market integration across Africa for the productivity and sustainability of traditional agroecological systems, for the conservation of crop genetic resources, and for the livelihoods, income, and food and nutritional security of smallholder farm households, this dissertation researched the case of cassava production in Cameroon in an area where conditions are theoretically quite positive for the adoption of such technologies. The intention was to critically examine the assumptions and underlying parameters posited by the Alliance for a New Green Revolution in Africa (AGRA), which are also explicit or implicit in the policies and programmes of the Government of Cameroon and of several CGIAR institutes that the Government collaborates with, and to reformulate these on the basis of the findings to provide a more adequate framework for approaching and assessing agricultural innovations in the African context. Cassava (*Manihot esculenta* Crantz) was the crop of choice due to its great significance for food security over much of Africa as well as across the tropics, and because it has been the subject of concerted plant breeding, research, and extension efforts globally, within Cameroon, and in the regions under study for at least three decades. This dissertation focused on questions such as: Are African farming systems, and farmers, characterised by attributes that AGRA ascribes to them? Are such farmers likely to accept the technologies that AGRA is promoting? Are AGRA technologies and strategies likely to lead to more sustainable, higher yielding farming systems? Are they likely to translate into greater market integration, higher incomes, greater food security, and renewed investment in agricultural intensification for small farm households? Are there not trade-offs that farmers and their households and communities have to confront and, if so, how might these influence their strategies and responses to programmes that promote Green Revolution-type intensification?

These questions were addressed by examining the assumptions and underlying parameters related to the promotion of 'old' or 'new' Green Revolution technologies and strategies by carrying out comparative analysis of two villages where cassava is a very important crop: Malende and Koudandeng. Over a relatively long period, these villages have been subjected, to a greater (Malende) or lesser (Koudandeng) degree, to government efforts to promote Green Revolution-type technologies (especially HYVs and fertilisers), and increased commercialisation of cassava, especially of cassava HYVs. These villages are located in one of Africa's 'cassava belts' where the agroecological potential for cassava production is good, cassava production is widely diffused among farmers, and cassava markets are good and accessible. The villages differ in that cassava is a principle dietary staple in Koudandeng, whereas in Malende it is mainly a commercial crop; Koudandeng is ethnically homogeneous and exhibits a high degree of adherence to cultural traditions and beliefs, whereas Malende is ethnically heterogeneous, there is lower degree of adherence to cultural traditions, and it has been the subject of intense government and NGO development interventions. While in both villages single species plantations and monoculture cultivation aimed at income generation have been present for quite some time, as is the case across much of Sub-Saharan Africa, most agricultural production continues to be based on traditional swidden polyculture fields.

These two villages were thus considered to represent an adequate empirical basis for examining the relevance of the goals, the validity of the assumptions, and the appropriateness of the modes of implementation of Green Revolution policies and programmes, as well for understanding some of the principle parameters that determine the performance of traditional African farming systems. Given the relatively high potential of these areas for cassava production, the Cameroon Government considered that it was likely that farmers would accept its recommendations about increased use of fertilisers and HYVs, and would seek to maximise income from agricultural intensification that would result in higher yields and greater market integration. However, after several decades of exposure to programmes that promote these ends, Malende farmers have accepted only a few of the available cassava HYVs, use fertilisers only sparingly, and continue to produce cassava principally in traditional polyculture systems. Koudandeng farmers have barely accepted HYVs and hardly use fertilisers on their annual crops, and their farming systems continue to be based on swidden fallows and an assemblage of polyculture fields. The research presented herein demonstrates that farmers have only exceptionally adopted Green Revolution technologies and modern farming strategies and systems (including monoculture) but further, it has sought to understand the reasons for this, and to explain farmers' and households' production systems and strategies from an emic (insider's) perspective.

If African farmers do not accept the Green Revolution technologies that are promoted, or accept them only on their own terms and in accordance with the outcomes that they themselves desire that differ significantly from what governments, researchers, and donors anticipate, then this may be attributable at least in part to the fact that the strategies and technologies that are promoted are based on erroneous assumptions, not least about the key parameters that define the performance of real African farming systems and real African farming households. The major conclusions of this dissertation are presented below in relation to these implicit parameters and assumptions, which were addressed in the research as hypotheses. It goes beyond this to propose other parameters and assumptions that may serve as a more adequate basis at least for initiating context-based (and thus local) research and technology development. The chapter is thus organised into two parts: the first presents and overview of the research results, and the second proposes policy recommendations that may serve as a point of departure for improving traditional farming systems in Cameroon and across much of Sub-Saharan Africa.

7.2 Major Findings: Assumptions, Hypotheses and Parameters

The assumptions made by AGRA are grouped around two sets of underlying parameters that are implicitly thought to determine the performance of African agricultural systems: one set is agroecological and the other is socio-economic. What is more, in AGRA's discourse, these parameters are treated as if they were separate: there is an absence of attention to the relations between the agroecological (or what can be termed environmental, or 'nature'), and the socioeconomic (or what can be termed 'culture'), which in turn leads to the inattention to the diversity of cultures and agroecologies across Africa – its biocultural diversity – that permits blanket recommendations to be made on the basis of over-generalised and over-simplified assumptions.

When consideration *is* given to the relations between culture and nature – that is, to the diversity of African cultures, agroecologies, and socioeconomic systems and relations, and to the relations between culture, agroecology, and socioeconomics – then three different interacting sets of analytical parameters emerge that must be considered if insights into real African agriculture and real African farm households are to emerge. Two of these sets of parameters emerge from a critique of AGRA's parameters, and a third arises out of a framework for assessing the acceptability of crop varieties that has its foundations in ethnobiology.

7.2.1 Agroecological Assumptions and Parameters

AGRA makes the assumption that traditional African farming systems and practices are unsustainable and suffer from low productivity. The first major parameter determining the performance of these systems is *the condition of soils*, which are characterised as 'naturally poor'. A set of variables are related to traditional farming practices (the second major parameter), particularly fallow periods that are recognised to have provided for nutrient recycling in the past, but that are said to be declining, and hence the third major parameter determining performance - *nutrients* - are being depleted. Farmers' maladaptive response to declining fallows and diminishing soil fertility is to mine the soil, rather than to use the only resource that could reverse such nutrient decline – chemical fertilisers. Soil mining leads to declining *crop yields*, which is the fourth major parameter determining the performance of African farming systems. Soils, nutrients, and crop yields thus form the basis of the performance of African farming systems, and traditional farming practices are seen to negative affect all of these. The exogenous parameters are poor soils, on the one hand, and population pressure, on the other, since this is what leads to declining fallow periods. These assumptions became hypotheses that were tested in relation to an analysis of Cameroonian cassava farmers' agroecological systems. AGRA's concern with soil conditions, nutrients, and crop yields as the central parameters are also addressed.

a) Soil conditions, nutrients, and farming practices

The assumption that African soils are naturally poor focuses attention on the chemical composition of soils, which is an oversimplification of the factors that determine the agricultural potentials of an environment. The diverse soil physical properties, relief, amount of vegetation cover, and agro-climatic conditions of different African regions, subregions, ecosystems, and niches are excluded from AGRA's characterisation of African soils. Cameroon has a range of soil types and ecologies that, over much of the country, and particularly in the South, are suitable for the types of crops that are grown. Malende and Koudandeng soils have good physical properties and medium to rich chemical composition, favourable relief, high vegetation cover, and good agro-climatic conditions (soil temperature and moisture, precipitation, and solar radiation), which determine their agricultural potential.

In any case, the properties of soils present a set of production conditions. Soil properties are obviously the subject of human manipulation and management. Malende and Koudandeng farmers' soil fertility management strategies enable an efficient and optimum management of soils and nutrients without the use of external inputs. These strategies are adapted to, and adapt, agroecological conditions using natural processes and inputs combined with accumulated knowledge and available labour to maintain soil fertility. These strategies are aimed at the optimum management of above- and below-ground nutrients. Cassava production in both Malende and Koudandeng occurs in traditional, multi-layered and multi-species polycultural fields with complex temporal and spatial configurations where myriad combinations of at least six to seven crops are grown per field. These fields in turn form part of an 'overlapping patchwork' of fields that are based on other major and minor crops grown in association, in varied sizes, distributions, and compositions. The spatial and temporal co-occurrence of the different crops and varieties respect specific ecological processes and principles such as nutrient recycling, facilitation, and complementarity, which reduces competition among intercrops and promotes weed control, and as well continuously modifies micro-environments and creates and uses specific niches. Intercropping long and short cycle crops and companion crops, which tolerate similar soil conditions but differ in their nutrient requirements, in specific planting densities reflects farmers' intimate emic understanding of crop autoecology and synecology.

Also contrary to AGRA's assumption about fallows, the findings are that, if fallow periods have decreased in the relatively distant past, they now appear to be increasing in the study area. Fallow lengths are varied and depend on farmers' production orientation (subsistence versus commercial), socioeconomic attributes (age, level of education), agroecological practices (fertiliser use or non-use) and characteristics (field location), and farmers' perceptions (evaluation of soil fertility). The fact that age, field location and, to a lesser extent, farmer education are important determinants of fallow lengths tends to indicate that labour constraints are better explanations compared to population pressure. Short fallow fields are not actually poor in chemical and physical properties as purported, and reduced fallow length does not necessarily imply a 'breakdown' in soil fertility. The type and diversity of fallow vegetation cover modifies soil characteristics and can maintain or improve soil fertility. Malende and Koudandeng fallow fields are also invaded by *Chromolaena odorata*, which enhances soil nutrient availability through rapid soil coverage and high litter and biomass production that is returned to the soil when cleared and burned.

In situations where shortened fallows lead to soils that are low in nutrients, farmers' crop management strategies improve their fertility to obtain good yields. These strategies include: i) managing vegetation cover through slash-and-burn to release a stock of nutrients, ii) practicing preferential placement of crops in microsites according to their specific nutrient requirements, iii) practicing agroforestry, iv) practicing crop rotation and succession, v) planting cover crops and legume trees, vi) associating specific types of crops with fallow fields of specific ages to suit biophysical and phenological needs, vii) incorporating crop residues into soils, and viii) practicing spatial and temporal crop associations that facilitate rapid nutrient recycling.

b) Crop yields

Making assumptions about the productivity of traditional African farming systems on the basis of the presumed yields of individual crops and concluding that such yields are uniformly low is problematic for a number of reasons. Most often, the yields of individual cereal crops are used to draw conclusions about the productivity of traditional African farming systems and the food production and food security status of rural households, even cereals may not be staple crops in many regions, and thus their production is likely to be low. In addition, statistical data on agricultural production and yields in Africa is notoriously deficient. According to the FAO (2002), the quality of agricultural data in developing countries and especially in Africa is dubious due to: i) the existence of high variation in the completeness of the statistics reported; ii) inadequate metadata on data reliability (inappropriate methodology, sample design and sample bias); iii) the existence of large informal economies that are often neglected in data collection exercises, and as a result most data are adjusted to reflect the informal sector based on cash crop export data; iv) problems related to the coherence of the statistics collected (different understanding and interpretation of definitions of production indicators at national level); and v) the problem of accessibility of data throughout the production chain. Berry (1984) argued that using aggregate production data for the whole of Africa in support of the decisions in relation to the African food crisis is misguiding because the sources of such data are very limited, given that national level data are not reliable or complete. Agricultural production data for Africa is derived mainly from foreign trade statistics, data on domestic purchases of agricultural commodities on the part of official marketing agencies, and agricultural census or sample surveys that are often sporadic and of limited coverage. In Cameroon, there is no agricultural statistic service that collects data at grassroots level, so that data collected by the National Agricultural Extension and Research Programme (NAERP or PNVRA) is used to derive national statistics. NAERP's mandate is to render backstopping services to a third of the total population of small-scale farmers, which implies that all data from NAERP that is representative of national production data corresponds to a third of the total national production data from small-scale farm households. Information from larger-scale producers is missing.

Another major reason for contesting AGRA's assumptions about yield is that the total output of companion crops that are grown in polyculture fields is much higher than the yields of individual crops grown in monoculture even when using the same planting density per unit area of land. The yield data of reference or single crop species are used to estimate the performance of traditional polyculture systems whose crops are often harvested piecemeal, which not only leads to an under-estimation of total yields, but also to partial yield values and, consequently, inappropriate policy recommendations. The notion of land equivalent ratio (LER) should be used to measure the output of polycultural fields, since it measures the aggregate yields of all companion crops for a given time period in a given space.

Below it is suggested that farmers do not seek to maximise the productivity of individual crops, but rather seek to optimise the output of their entire production system with respect to various goals, such as achieving year-round food security and maintaining indigenous foodways. Achieving year-round food security might imply a trade-off between maximising total production at a given point in time and ensuring continuous harvest of certain crops, or obtaining a harvest at a point in time when food resources are scarce. Other goals, such as ensuring soil fertility and sustainability of production over the long term may also affect farmers' ability to achieve the maximum possible yield at a given moment in time, as organic farming practices in the North clearly demonstrate.

It is argued that, rather than supporting smallholder agriculture in Africa, policies and interventions that promote maximisation of individual crop yields and the use of fertilisers can undermine many traditional agroecological systems without providing compensating benefits. Using fertilisers in traditional polyculture systems has technical and practical limitations:

a) Farmers will be encouraged to reduce fallow lengths if they use fertilisers;
b) Reduced fallow length may entail continuous cropping without nutrient recycling, which can lead to rapid depletion of soil nutrient stocks, as well as of soil carbon;
c) The difficulties entailed in the estimation of optimum fertiliser requirements for individual crops in polyculture fields lead to faulty or partial estimates of soil nutrient balances and therefore incorrect technical recommendations whose consequences are varied and range from low crop yields (if excessive nitrogen is applied), through increased depletion of some nutrients, to increased costs due to wasted fertilisers. Making useful recommendations for fertiliser use requires a more holistic approach to the calculations for individual fields' soil nutrient balance;
d) Using fertilisers involves a series of practical limitations, some of which are: the existence of appropriate fertiliser mixes for broad applicability and unknown nutrient requirements of polyculture systems; the inappropriateness of AGRA's knowledge-intensive Integrated Soil Fertility Management and soil testing approaches for small-scale African farmers and African governments; the high prices of agrochemicals and vulnerability of traditional farming systems to fluctuations in market prices and availability given projected shortages of fossil fuels and phosphate rock; and the risks of health hazards from high concentrations of chemicals in crops.

Manufacturing fertilisers that suit the soil condition of each farmer is a major challenge, whereas farmers themselves tailor their nutrient management strategies to their field conditions. Traditional soil fertility management practices do not require cash outlays, and fertiliser purchases will increase farmers' financial burdens, especially affecting women and those who own no land.

7.2.2 Acceptability of Local Cultivars and HYVs: Assumptions and Parameters

AGRA makes the assumption that farmers' local varieties (or landraces) are low yielding and are highly susceptible to pests and diseases compared to HYVs, which nevertheless must be bred for specific agroecological conditions with farmer participation**.** The major parameter determining the performance of traditional African farming systems is thus, once again, crop yield, but in this case yield is determined not by soil fertility, but rather by plant genetics, expressed as *crop varieties*. While AGRA recognises that local varieties are adapted to local environmental conditions and have other characteristics that farmers desire, it still presumes that plant breeders, working together with farmers, can improve these varieties, e.g. to increase pest and disease resistance, in order to increase overall yields.

Plant breeders have been working toward these ends in Cameroon and in the CGIAR institutes for a number of years, albeit with a greater or lesser degree of farmer participation in the process. The state institutions that provide agricultural research and agricultural extension services are located in two ministerial departments: the Ministry of Scientific Research and Innovation (in the case of agricultural research), and the Ministry of Agriculture and Rural Development (in the case of agricultural extension). As such, farmers' participation in plant breeding activities involves two channels: it occurs either through the research-extension-farmer linkage, which depends on funding for extension services and therefore is often very weak, or through direct involvement of researcher-breeders with a few farmer organisations, especially producer unions or federations that are located at provincial and divisional administrative levels. Working with unions and federations, researchers assume that information and innovations will trickle down to those farmers' organisations at grassroots level that are members of these unions and federations. However, this has not been demonstrated to be an effective tool for the dissemination of innovations due to the distortion of information and the neglect of the needs and interests of the farmers who mostly manage a diversity of small-scale farming systems in diverse agroecological conditions. Research institutions in Cameroon are not well represented at the grassroots level compared to the extension institutions, which are well represented.

The hypothesis that was tested in Koudandeng and Malende was that, if African smallholders' objective is mainly to increase productivity (yield per unit area) and, if local varieties are actually low yielding, HYVs should out-compete local varieties. HYVs should have a higher level of salience for farmers compared to local varieties due to their comparative advantages. The hypothesis was tested by collecting and analysing data on vernacular varietal names and their logic, on the salience of local and HYV cassava varieties, on the attributes that order the ways in which farmers perceive varieties, on intra-cultural variation in varietal salience and attributes, and on actual varietal diversity in farmers' fields and the factors that influence such diversity.

a) Crop yield and pest and disease resistance

Basing recommendations for the use of HYVs rather than local varieties on the evaluation of their respective yields is misleading because, although yield and pest and disease resistance are important varietal selection criteria for farmers, they are only some of the criteria that influence decision making about which varieties to grow. Ensuring food security including year round food availability, meeting culturally determined culinary requirements, generating income, and dealing with labour constraints are other major concerns. Moreover, farmers perceive that some local varieties are higher yielding than the HYVs that they grow.

The level of salience (meaningfulness) of each variety was closely examined. HYVs are generally less salient compared to local varieties, especially in Koudandeng where cassava is the main dietary staple. The varietal attributes that confer greater meaning determine the acceptability of HYVs. Of the 13 cassava HYVs that were released to farmers between 1986 and 2002, only two have been accepted by less than 50% of farmers in Malende, where cassava is a commercial crop. HYVs are not meaningful to Koudandeng farmers and so are rejected by all but four farmers who grew one HYV in 2006. While HYVs are grown in Malende, their populations are lower relative to the populations of all local varieties combined.

When farmers incorporate HYVs into their systems, they do so because they have specific commercial advantages: they are early maturing and thus have quicker turnover rates (two crops of HYVs can be harvested in less than two years), which increases the volume of sales and generates higher levels of income compared with slower maturing varieties. However, HYVs are perceived to have certain advantages and disadvantages when it comes to processing qualities (e.g. high water content, which makes processing easier but reduces the volume of processed products; poor taste, but smooth paste), but in general the products made from them are less acceptable to consumers and hence receive lower prices in the market. Malende farmers thus develop strategies to overcome such limitations and facilitate the sale of cassava HYVs and products made from them. These include processing more HYVs during the periods when processed cassava products are scarce and consumers are willing to pay for any processed product, irrespective of the quality; processing HYVs into products where the HYV qualities present advantages rather than disadvantages; mixing HYVs and local varieties before processing into certain products, where HYVs make up the minority of the total volume processed; and selling HYVs as standing plants in the fields, thus saving time spent in processing that is insufficiently remunerated compared with the time spent processing local varieties, given the higher income received for the same quantity of processed fresh roots. Lower unit income from the sale of HYV-based processed products is compensated by faster turnover rates. But it is clear that, in order to sell HYVs in processed form at all, farmers must also produce the local varieties that are preferred by consumers and that have the desired processing characteristics. Thus, farmers *must develop strategies to be able to incorporate HYVs into their production systems at all*; they develop such strategies only in the case of a few HYVs that have certain clear advantages with respect to their own varieties, where such strategies are feasible given the balance of positive versus negative (production and processing) attributes, and where the crops are grown for purposes of generating income rather than to meet own food consumption needs.

While pest and disease tolerance is an important evaluation criterion for farmers, it was only in 2007 that a variety that is tolerant to the root rot disease was developed. Root rot was not considered to be as significant compared to the cassava mosaïc virus (CMV), cassava bacterial blight (CBB), cassava mealybug and green mite pests that were considered. In farmers' minds, however, root rot is closely associated with underground storability, an aspect that correlates with farmers' strategies to ensure year-round food availability and income. Generally, farmers combine varieties that are less susceptible to root rot and can be stored for long periods underground with those that are moderately or highly susceptible to the disease but have other desirable qualities. Pest and disease susceptibility and long underground storage are a major concern for women who are the main cassava producers, processors and marketers as well as those who must ensure household nutrition.

Farmers thus grow a portfolio of varieties, each which have a unique set of attributes, in accordance with cultural factors and social relations (especially foodways, social status, and religious beliefs), and to generate income while managing labour constraints. Farmers' primary objective is not to maximise yields of a specific crop or to maximise production of a specific variety, but rather to ensure livelihoods while meeting cultural needs. Therefore, a combination of factors determines farmers' varietal perceptions and use, which contributes to the maintenance of greater cassava diversity and only low acceptance of HYVs.

b) Farmers' classification, intra-cultural variation, and participatory plant breeding

Farmers cannot necessarily account for all of what they prefer to grow consciously. Their classification systems are, like all other cultural phenomena, to a certain degree innate. Within any given agroecological or cultural system, farmers are also not all alike: their understanding and knowledge are associated with their individual social positions and relations as men or women, elderly or young, formally or informally educated, market oriented or not, as well as with their idiosyncrasies.

Malende and Koudandeng farmers classify cassava varieties based on morphological, functional, spiritual, and cultural attributes. Their cultural classification systems group varieties into clusters such that, if a cassava variety has one of the cluster attributes, it is also more likely to share the attributes of other varieties in the cluster. Not all of the varieties belonging to one cluster are included to the same degree. Local varietal classification systems are culturally nuanced, and thus are specific to local cultural groups and social positions, whereas scientific or crop breeders' classification systems are obviously not, and the latter invariably emphasise what is in the mind of the scientists or breeders and what is associated explicitly with their goals: global validity and agroecological or agronomic characteristics such as yield and pest and disease resistance.

Varietal salience is not only a cognitive construct that allows people to order the biological world: it is also a significant determinant of what farmers actually grow (diversity in the field). Consciously or unconsciously, farmers diversify the varietal portfolios in their production systems to include a range of varieties from different clusters. This diversification, which is determined by a complex interacting set of cultural values, livelihood options, and socio-economic and agroecological conditions, varies across farmer sub-groups.

In relation to the variation in varietal salience and perceptions according to social position (farmer sub-groups), it was shown that the number of varieties grown, family size, age, level of education, household headship and household HIV/AIDS status significantly influence salience among more ethnically homogenous, subsistence oriented Koudandeng farmers. The number of varieties grown and ethnicity are significant determinants of varietal salience among more ethnically diverse and commercially oriented Malende farmers. Sex is not statistically significant in explaining varietal salience and knowledge in Malende or Koudandeng, and the degree of salience of HYVs is similar for both men and women in the two villages. However, in Malende, where men and women both grow cassava, there is a difference in varietal perceptions. The most salient attributes for men relate to rapid turnover (a preference for early maturing varieties without considering the length of underground storage, where HYVs meet these criteria) and palatability, and men generally cluster the highly salient HYVs together with the most salient local variety. The most salient attributes for women are those that facilitate the achievement of their multiple functions as producers, processors, and marketers of cassava and who ensure family nutrition. As such, their varietal classification systems take into consideration agroecological, food security, culinary qualities, and income. Their criteria are more numerous relative to men's: they classify their varieties in terms of phenotype, susceptibility to root rot, ability to produce yields even on overworked soils, long underground storability, and processing qualities and suitability for making specific products. Marketability may not be significant, but it depends on the qualities of the processed products and the suitability for making specific products for sale. In this case, processing qualities include fresh tuber dry matter content, which is closely linked to the weight and volume of processed products, and the colour and texture of processed products. The need for cash outlays is significant for women because planting material is increasingly commercialised in Malende: scarce and valuable varieties must be purchased. Labour is an important constraint and labour is hired most for processing and weeding, so women separately group those varieties with thick canopies that suppress weeds. The findings also show that a higher proportion of men grow HYVs compared to women.

In the more subsistence oriented Koudandeng, where cassava is the main dietary staple, it is principally a women's crop. The varieties that are meaningful to the few men who produce cassava are those that are sweet (unsurprising since they do not require processing and it is commonly believed that cassava that is eaten raw improves male fertility).

With regard to the influence of the HIV/AIDS epidemic on cassava varietal salience and knowledge, it could be expected that it would (a) negatively affect farmer knowledge due to the failure to transmit such knowledge across generations; and (b) reduce labour availability, which may lead to either a loss of varieties or a preference for varieties that require less labour, or both. It appears that the pandemic has not yet negatively affected farmer varietal knowledge, but it would be expected that such an effect would appear only after a larger number of households or an entire generation within households have been affected. While there is no significant difference in the number of varieties grown by HIV/AIDS afflicted and non-afflicted households in Koudandeng, all varieties that are grown by farmers in afflicted and likely afflicted households are sweet and thus require no processing, and are most are early maturing. These are mostly local landraces and a few newly introduced landraces. Farmers in non-afflicted households, in contrast, grow both sweet and bitter varieties. While the HIV/AIDS pandemic has not negatively affected farmers' knowledge of the varieties, it seems to bias varietal management toward those that require less labour for processing, which may have implications for varietal diversity in the long run. As cassava HYVs are currently bred and disseminated, rather than representing a major boon to farmers, they have not been shown to be a cost-effective way to improve the performance of farming systems or household welfare.

A cognitive ethnobiological approach was developed and tested to systematically and effectively capture farmers' knowledge and relate this to their practices (what they grow) in Malende and Koudandeng. It is proposed that this methodology may be useful for capturing farmers' knowledge and relating it to their practices while recognising and dealing with the existence of intracultural variation among farmers in agricultural research and development.

7.2.3 Socioeconomic Assumptions and Parameters

AGRA makes the assumption that, across Africa, *per capita* food production is declining. Population pressure is increasing and thus many rural people confront hunger. Farmers are poor and in need of additional income and, if given the opportunity, they will seek to maximise their income from crops sales, which they will in turn reinvest in agriculture. Farm households are food insecure and, by increasing their output through the use of HYVs and fertilisers and increasing sales, they will become food secure.

The primary parameters that are put forth to explain and predict farming system performance are *population pressure* and *income-seeking/profit maximising behaviour* of farmers. Poverty and food insecurity are a direct outcome of population pressure (which, as indicated above, also leads to decreasing fallows, mining of soils, and thus decreasing yields). The discussion of population pressure as a primary driver of poverty and food insecurity in Africa is beyond the scope of this study, however, even a cursory review of the literature on the relation between population growth, agricultural intensification, environmental degradation, poverty, and food insecurity shows that the relations between these variables are very complex and that such relations vary greatly in accordance with local conditions and contexts (e.g. e.g. Birdsall et al., 2001; Jayne et al., 2003). In Sub-Saharan Africa, it is likely that it is the inequalities in the distribution of resources, particularly of land and labour, that has the greatest importance for rural poverty and for the potentials for agricultural growth to alleviate poverty and food insecurity, rather than population numbers *per se* (Jayne et al., 2003).

What this dissertation did explore in some depth is whether farmers' behaviour and decision-making reflects the suppositions put forth by AGRA, or whether other factors have greater explanatory power in relation to farming system performance, particularly in reference to food security. The principle hypothesis that was tested was that, in the study area, which is representative of the 'high end' of cassava production in Cameroon, cassava farmers' objectives are to ensure food security and a livelihood. Further, their food production systems actually achieve these objectives, but cassava HYVs cannot meet these objectives and in fact contribute relatively little to these ends. The hypothesis thus challenged three assumptions: that farmers' objectives are to maximise income, that farm households are food insecure, and that HYVs represent a solution for farmers that will maximise income and overcome food insecurity.

Findings show that traditional cassava polyculture systems are not oriented exclusively, nor even primarily, toward maximising income: rather they are oriented toward meeting a much more complex set of needs and interests. Apart from satisfying nutritional and food security needs and generating income, the crop types and varieties that farmers grow are determined by a number of factors that are intertwined in a complex web of fabric that constitutes their livelihood strategies, which are cultural, nutritional, economic, social, and spiritual, and which strongly consider labour and land constraints.

a) Household food security, nutrition, and foodways

A primary goal of Koudandeng and Malende farmers and their households is to achieve food security. They are able to achieve this with their existing production systems. But the concept of food security (in terms of access to sufficient quantities of nutrients) is insufficient to characterise what farmers attempt to achieve: their strategies are aimed at ensuring access to sufficient food in accordance with their culturally-defined foodways, and it is largely this which orients their farming systems and crop diversity.

Traditional farming systems are polycultures that are managed to ensure year-round availability of food, thereby providing food security for households. The complementarity of food crop fields, crops, and varieties; the seasonality of production and patterns of harvesting of individual crops and crop varieties; and the relation between food crop diversity and traditional dishes and diets, are important factors in farmers' decision making related to their choice of crops and crop varieties that must be considered in food security policies. These strategies include: i) managing a diversity of food crop fields, crops, and varieties that provide a diversity of nutrients; ii) orienting their production toward year-round food availability; iii) consuming the largest proportion of their farm produce; iv) selling surplus production which permits them to purchase the food items that they do not produce; and v) redistributing food between households to fulfil social obligations, which also provides them with access to additional resources such as labour, cash, and food in times of need. Koudandeng and Malende cassava farmers do not confront problems with food security and malnutrition since they grow most of the food that their households need in their traditional intercropped fields, which provide a nutritionally adequate diet. There is a clear link between agrobiodiversity, dietary diversity, and nutritional diversity and security. Farmers' traditional dietary patterns thus appear to be such that nutrient deficiencies are avoided or reduced to a minimum. The dietary constituents and the functional properties of the diverse traditional crops in traditional polyculture systems contribute to the prevention or lowering of the risks of chronic disease.

Local foodways determine both the crops that are grown and the products that are sold in local markets. Traditional polyculture systems and the crops grown in association are in part based on local foodways, and farmers plant a combination of crops to meet their food traditions and needs for dietary diversity and therefore consume dishes that are constituted of various combinations of these crops and wild food plants. A plantain/banana-based polyculture field in Koudandeng, in which plantain, banana, cassava, cocoyam, groundnut, and African plum are planted as companion crops, provides at least nine different dishes; a cocoyam-based polyculture field in which cocoyam, maize, groundnut, egusi, cassava, colocasia, green leafy vegetables, and plantain are grown in association, provides between 10 and 13 different traditional dishes, depending on the ethnic origin and food habits of the farmer. Cassava and cassava products occupy a central place in the traditional diets of the two villages. It is grown for own consumption and sale and is either eaten boiled or processed (boiled and pounded, pounded, milled, grated, fermented, and distilled). The cassava products eaten in Koudandeng include ndeng (baton), boiled fresh roots, raw fresh roots, vouvou (couscous or cassava flour), beigner (fried cassava and ripe banana paste balls), chips, and kwem and muengwalla (a drink). In Malende, cassava is eaten in the form of gari, water fufu, myondo (miondo), boiled fresh roots, fufu (pounded boiled roots), and makra. Taste, aroma, colour, texture, and suitability for processing into specific products whose consumption varies according to ethnic group, largely determine the mix of cassava cultivars in farmers' fields as well as the acceptability of HYVs.

The low acceptability of HYVs among consumers, who largely share farmers' cultural food traditions and preferences, means that unit prices for processed products made from HYVs are lower compared with those made from local cultivars. It is farmers' own food choices and preferences and those of other local populations that determine which crops are grown and sold in local markets. Farmers have developed and adapted cassava varieties over time to their agroecological conditions and foodways, and agroecological conditions and foodways have likewise evolved, that is, they have co-evolved. Cassava and cassava products occupy a central place in traditional diets, especially among the people of Koudandeng, for whom cassava is the main staple. The acceptability of local varieties and HYVs depends on their suitability for making various products, which is a reflection of local foodways. The different cassava varieties have different combinations of characteristics and since no 'ideal' variety exists, farmers maintain a range of varieties that have specific traits. A few of the HYVs have some of the qualities that are desired for producing some of the processed products but, generally speaking, most of the local cultivars have more of the desired characteristics, which is unsurprising given that farmers have developed or adopted them because they do have such characteristics. The wide scale acceptance of HYVs that the Government of Cameroon has promoted for almost 25 years (since 1986) has been largely unsuccessful in the study areas.

b) The social and economic functions of food: what use for surpluses?

There are two other important objectives that farmers have when growing different crops in both villages beyond meeting household food security needs within the context of local foodways: to meet social obligations among kin and within the community, and to generate income. Farmers not only meet household subsistence needs; they also produce surpluses, but these surpluses are not solely destined for the market. It was found that specific food crops were produced for household consumption only, for sale and consumption, for consumption and gift giving, or for all of these ends, but no food crops were produced only for sale: households eat all of the food crops that they grow, although in varied proportions.

Koudandeng and Malende households not only have physical access to food through own production and purchase, but also through redistribution, and they strive to meet social obligations related to food sharing, which ensures social access to food as well as creating and maintaining social relations between individuals and households. Providing food for social events and for guests, as gifts to kin, as contributions to family members living in urban areas, and to people in the community who have met with misfortunes of various types, are all different types of social obligations that people must meet if they are to remain in good standing in the community, and to access other resources (e.g. labour, loans, land, etc.), where each of these may also require certain types of foods (e.g. baton) and thus require certain cultivars. African societies continue to be lineage-based, and kinship and other social obligations play a fundamental role in social organisation and in production that they do not play in other cultural contexts, e.g. in much of the developed world. The importance of meeting social obligations and respecting the bonds of kinship or patronage cannot be under-estimated as a parameter in Africa farming systems, as Berry (1984), for one, noted when referring to agrarian change in Africa and to the use of agricultural surpluses:

> …to the extent that access to land, labor, credit, and commercial opportunity was predicated on ties of kinship, traditions of common origin, relations of patronage, and so forth, such social relations became objects as well as instruments of accumulation. Resources were, accordingly, channelled into transfers (e.g. gifts, favors, labor service, bridewealth) or outlays on entertainment or ceremonial consumption, rather than on the creation or acquisition of productive capital…[In addition,] viable systems of family labor rest on long term, mutual obligations rather than flexible, short term systems of incentives [such as wage payments or profits] (pp. 92-93).

Farmers have other livelihood activities in which they invest cash and labour, and high investments in inputs for cassava production, especially in HYVs, fertilisers, and labour, are likely to compete with investments in other income-generating and investment activities. Especially women farmers' income-generation objectives are oriented toward i) payment for children's education (school fees, books, stationery, uniforms, and shoes), ii) provision of health care for families, iii) payment for household provisions and the food items that women do not produce, especially for protein (smoked and fresh fish, meat), iii) payment of hired labour, iv) making contributions to social and political gatherings as well as for important feasts (marriages, births, deaths, Christmas, New Year and National holidays) and to the church, and v) securing access to credit to facilitate the establishment and management of food crop fields. Farmers, especially women, rely heavily on the sale of their diverse food crops to meet these financial obligations. Most of the crops that are sold in large quantities are legumes (pulses, green leafy vegetables, okra) and cereals, with the exception of plantain and cassava, which are main sources of carbohydrates that are produced in large quantities, much of which cannot be consumed by individual households. However, the degree to which each crop contributes to household income varies by village. For example, cassava, egusi and, to a lesser extent, groundnut, maize, and plantain, are major sources of income for more commercially oriented and ethnically diverse Malende households, whereas cassava, groundnut, maize and, to a lesser extent, plantain and banana, are major sources of income for Koudandeng households. In order of importance, cassava is the most important source of income for 93.3% and 73.3% of Malende and Koudandeng households, respectively, compared to the proportion of households that earn income from the other crops. The common saying among women is, “A woman without a cassava field is a living corpse.” The cassava products sold are diverse and are determined by the traditional foodways and dietary patterns in the regions. In the more subsistence oriented Koudandeng, cassava is sold every three to six months in all forms. In the more ethnically diverse Malende, cassava sales are mostly weekly, and gari and, to a lesser extent, water fufu, are the main forms sold. While cassava constitutes an important source of income for women, it is an alternative source of income for those men who take up production. Not all varieties have high market value and therefore are not sold in the same proportions. Varieties that have most of the attributes that are desired by consumers have higher market value than others that do not and, generally, even though the local varieties do not have all of the desired characteristics, they have a comparative advantage over the HYVs. Not all of the HYVs have low value since some have some of the qualities that consumers’ desire.

Apart from income generation and investment in agriculture, other livelihood activities include petty trading in foodstuffs, beer and provision shop management, wild food plant sales, wage labour in agriculture and food processing, land rental, professional activities (sewing, hair dressing, carpentry, plumbing), salaried employment (nursing, driving), and transfer payments (pensions, remittances). Generally, such activities provide about 50% or more of total income for 23% of Koudandeng households and over 60% of income for only 13% of Malende households. This clearly shows that Malende households depend more on agriculture for income compared to Koudandeng households. However, agriculture still constitutes the main source of income for farmers in both villages, where it contributes about 52% of total income for 77% of Koudandeng households and over 60% for 87% of Malende households. Even though a greater proportion of farm households depend on agriculture for income, it can be said that income generation through agriculture serves particular functions but it is not the exclusive goal of farm households. Also, it is questionable whether farmers are likely to reinvest the income generated through agriculture in agricultural inputs or expanded production:

> Successful farmers encounter a further, related difficulty if they seek to reinvest their profits in increased productive capacity. Many farming systems in Africa economize on labor by carefully adjusting combinations of crops and sequences of tasks to local environmental and social conditions rather than by combining labor with large amounts of capital. Cultivation methods often do not involve significant economies of scale, and enlarging a farming enterprise is likely to increase a farmer’s managerial responsibilities without effecting corresponding reductions in unit input costs. In addition, to the extent that opportunities for profit-taking are greater in the tertiary sectors of African economies than in agriculture per se, successful farmers tend to diversity their portfolios, using the proceeds of their farms to invest in trade, urban real estate, or their children’s education rather than in expanded agricultural production. (Berry 1984: 93).

Thus, AGRA's strategies rest on the belief that African smallholders will act like small American or European entrepreneurs, rather than as rational individuals who are embedded in specific social relations that have developed in specific cultural and historical contexts and that are subject to specific resource constraints and dynamics. With respect to the acceptance of HYVs, farmers act rationally by accepting those varieties that have the desired qualities that help to fulfil their multiple goals. Since no variety actually exhibits all of the desired qualities, farmers manage a diversity of varieties, including some HYVs. While HYVs have some benefits, they generally have low acceptance among farmers and consumers, so that farmers generally earn lower income from sales of cassava HYVs and their products. Farmers have devised strategies to compensate for these disadvantages, but such strategies continue to be based upon polyculture production systems and local varieties.

7.2.4 The Missing Relations between Agroecology ('Nature') and Socio-economic ('Culture') Parameters and the Potential Dangerous Consequences

Agroecological and socio-economic phenomena do not occur in isolation. Humans influence agroecosystems and their services, and these in turn influence human behaviour. AGRA posits that population growth leads farmers to reduce fallow lengths, which reduces soil fertility, which causes farmers to mine soils, which in turn leads to declining yields. This is a chain of events where nature and humans are interacting in a causal manner so that both simply deteriorate: neither appears to adapt - only to maladapt. The solution is equally straightforward: humans can fix nature by introducing fertilisers, practicing integrated soil management, and using high yielding varieties, so that the yields that are required will be produced, and people will make use of these yields (through markets) to further fix nature. AGRA apparently doesn't address population growth because its ranks are made up of plant breeders, agronomists, and agricultural economists, and not of demographers.

AGRA thus fails in any way to problematise the relationship between nature and culture in Africa. Farming systems and their crop diversity are seen as separate from social and cultural relations rather than as an outcome of such relations. The assumptions behind the promotion of such recommendations are reductionist, do not take into consideration the complexities of African agriculture and livelihoods, or the interrelation between farmers' social and cultural behaviours, resource access, values, norms, and beliefs and how they carry out agriculture (e.g. spatial and temporal configurations, cropping patterns, crop and varietal choices, cultural practices). Across most of Africa, smallholders and their agroecosystems are firmly embedded in ethnic and tribal communities that adhere more or less strongly to cultural norms, beliefs, and kinship or lineage-based social relations. Their agricultural knowledge and practices are often based largely on local knowledge and resources. Such 'traditional' agricultural systems generally represent a long-term adaptation between culture and nature, where both have co-evolved over time. Farmers' knowledge and practices are embedded in social relations, where many modes of subsistence are characterised by forms of communalism that are relatively egalitarian, which tends to ensure that resources are distributed in such a way that people have sufficient means to meet socially defined, as well as biological needs. Further, subsistence practices that tend to ensure that natural resources and ecosystems are sustainably managed are often embedded in traditional belief systems that imbue the natural world with symbolic and religious meaning, and that see humans as an integral part of nature. Unsustainable practices and inegalitarian social relations are likely to be mal-adaptive over the long run, and societies that have persevered over long time periods are seen by scholars to be largely adaptive, sustainable, and resilient.

AGRA-type recommendations thus drastically over-simplify traditional African farming systems and ignore their diversity. Eight major critiques of this over-simplification and the resultant dangerous consequences for African farm households can be identified:

1. The recommendations for integrated soil fertility management practices and fertiliser use have major technical and practical limitations and are inappropriate for most African contexts. These include: the difficulties entailed in estimating the correct soil nutrient balance and recommended crop nutrient requirements (in general and for individual farmers' fields), which could lead to inappropriate recommendations for fertiliser use with the related consequences being low crop yields, increased depletion of soil nutrients, and increased costs due to wasted fertilisers; the difficulties entailed in manufacturing fertiliser mixes to suit farmers' diverse agroecological niches for broad based applicability; the inappropriateness of recommended knowledge-intensive soil experiment and testing approaches for farmers (in terms of cost, time, individual interpretive diagnostic skills and knowledge and wastage of reagents); negative implications for the sustainability of traditional polyculture systems due to the tendency toward reduced fallow lengths to permit the use of fertilisers; high prices and vulnerability of dependence on agrochemicals, as well as risks of health hazards from high concentration of chemicals in crops. The technical and practical difficulties entailed in combining chemical fertilisers and farmers' traditional organic matter and vegetation management practices to increase production and productivity are not considered.

2. The recommendations for integrated soil fertility management practices do not take into consideration farm households' social constraints: differential access to income, land, and labour, and investments in other livelihood activities that compete with investments in agricultural inputs, which consequently may have implications for soil fertility management. Traditional soil fertility management practices do not require cash outlays. Farmers' use of fertilisers will increase their financial burdens due to the costs entailed, possibly provoking a shift to monoculture to raise individual crop yields and therefore leading to the need to acquire more farmland to grow individual crops. Such costs and options may be impossible for women and landless farmers.

3. Using yield as a criterion to evaluate the performance of traditional African polyculture systems, the emphasis in Green Revolution-type programmes has been on crop genetics, where tolerance to pests and diseases, high individual crop yields, and adaptation to a wide range of ecological conditions and farming systems have been the main focus. In breeding cassava for disease tolerance, the emphasis had been on controlling diseases that reduce leaf life or photosynthetic efficiency, or cause stem damage or high levels of early plant death, since these were judged to be of greatest economic importance. Breeding for resistance to diseases that cause plant death on a moderate scale, provoke only small decreases in root numbers or small decreases in leaf size, was not prioritised. As such, varieties were bred for resistance to fungal and bacterial diseases: cassava mosaic disease (CMD), cassava bacterial blight (CBB), cassava black streak disease (CBSD), green mites, mealybugs, and whiteflies. IITA and the Tanzanian Agricultural Research Institute (ARI) released a variety that is resistant to black streak disease, which causes the root rot that affects most of the cassava varieties in the study area and sometimes causes over 50% of

losses in production. However, replacing the susceptible varieties with the newly released resistant variety will take about 8-12 years if conventional methods are used to produce them, even though molecular markers could be used to reduce this time lag.[18] Further, the acceptability of these new disease resistant varieties is likely to be problematic if they do not have the other traits that farmers desire.

4. Unless farmers are principally oriented toward producing for extra-local markets (e.g. export, industries), it is their own food choices and preferences and those of other local populations that determine which varieties they will grow and sell in local markets. Greater emphasis on productivity and environmental variables in plant breeding has downplayed the need to of develop varieties that taste good and have other qualities that are suitable for making popular African dishes that are acceptable to consumers. Except for gari and cassava flour, where cassava breeding programmes have targeted food quality improvements because they are the major cassava commodities and thus potentially subject to mass production and homogenisation in Africa, breeding for suitability for making the diverse traditional diets of Africa and Cameroon in particular (such as water fufu, bobolo, miondo, couscous, meungwalla, masoma and makra) has yet to occur. The attention to cassava flour is due to the fact that it constitutes a raw material for agro-food processing industries where it can be used to partially substitute for wheat flour. However, African consumers prefer the traditional products, which helps to establish the link between consumers and farmers and provides farmers with remunerated added value. Cassava and its products constitute local indigenous varietal foods that are adapted to the local environment, and people who do not have access to these local diverse foods through own production support farmers through purchase. The loss of such local markets implies lower income for farmers.

5. Farmers' strategies for ensuring household food and nutritional security are determined by their foodways, which in turn influence farming systems and crop diversity. Large-scale adoption of HYVs may lead to household nutritional insecurity that results from the simplification of traditional farming systems and thus of diets. Mass production of varieties that are suitable for making gari and cassava flour implies the loss of local varieties that are replaced. The implications are reduced varietal diversity, which in turn leads to shifts in and simplification of dietary patterns and thus reduced dietary and nutritional diversity. The implications of reduced nutritional diversity and dietary constituents and their related functional properties for human health have been associated with increased risks of exposure to non-communicable illnesses such as heart diseases, diabetes, prostrate cancer, and cataracts, and higher rates of morbidity and mortality. The simplification of human diets that is associated with increased access to cheap agricultural commodities, together with the erosion of agrobiodiversity that such agricultural homogenisation entails, lead to nutrient deficiencies and excess energy consumption. Large-scale production of cheap agricultural commodities does reduce hunger and increase *per capita* energy consumption, but it also has adverse effects on dietary quality and undermines the food self-sufficiency of small-scale farmers. Crop diversity, dietary diversity, and nutritional diversity and security are interrelated, and therefore a change in one affects the remainder. It can be said that a major limitation of plant breeding strategies and programmes is the neglect of traditional foodways, nutritional diversity and security, and the cultural, spiritual, and economic sig-

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[18]See http://iita.org/cms/details/news_feature_details.aspx?articleid=1048&zoneid=81and 3152&zoneid=81

nificance of cassava, which has negative implications for food security attainment and health.

6. Participatory plant breeding is envisaged as a solution to the food problem in Africa, where it is assumed that local cultivars that have the desired characteristics do not exist. Further, plant breeding strategies have been guided by the belief that breeding for one characteristic (e.g. disease resistance, yield) will maintain the other qualities that farmers desire, which has led to the neglect of farmers' knowledge and preferences. While AGRA recommends that a partnership be formed with small farmholders and especially women in order to draw upon their local knowledge in breeding programmes, there seems to be no methodology to effectively and systematically access and document farmers' varietal knowledge, perceptions, and preferences, and relate these to farmer behaviour when adopting crop varieties. Most participatory plant breeding and evaluation approaches involve one or more of the following methods: preference ranking of varieties to permit identification of those attributes that farmers consider to be most important, farmer ranking of varieties per important attribute, or surveys asking farmers about varietal attributes accompanied by regression analysis against farmer socioeconomic characteristics to determine preferences for and classification of crop varieties. Some attempt to analyse farmers' perceptions of crop varieties by evaluating the level of adoption of HYVs or use econometric modelling methods such as simultaneous estimation to analyse conservation of crop biodiversity and HYV adoption. Most often, such methods are applied in isolation and, at best, they can provide only a partial understanding of certain factors that influence farmers' conscious decision making. Coherence in the application of such methods is often lacking. Intra-cultural variation among farmers in relation to their preferences for specific varieties is also difficult to consider in plant breeding efforts. If breeders modify their strategies to increase farmer participation, their breeding partners may be limited to specific categories of farmers and thus the varieties bred may not meet the needs of a majority of farmers. The difficulties and costs entailed in breeding varieties to include all or most of the characteristics (socio-economic, cultural, agroecological) that farmers' require results in breeding for one or two characteristics that are easily measurable. AGRA proposes to breed for local agroecologies while taking into account farmers' preferences, but the scale at which this should occur has not been specified. If the scale is sufficient to capture much of the diversity of African agroecologies and cultures, then the costs of such breeding programmes will be very high indeed, which does not accord with African economic or political realities. In Cameroon to date, cassava breeding programmes have been oriented toward meeting 'global' rather than local conditions. The lack of Government support for varietal breeding programmes that meet local farmers' needs has limited the Government's activities to adaptive research and plant material multiplication for onward release to farmers, where IITA's germplasm is the sole source of HYVs.

7. Cassava and cassava products play an important role in farmers' strategies for ensuring food security in both study villages. Ensuring physical and social access to food, and ensuring income generation, are households' major means to ensure food security, which must be considered together rather than in isolation when defining agricultural development and food security policies. Households are not desperate, but are able to produce not only what they consume but also process and sell cassava to obtain higher incomes, which enables them to purchase high protein foods and other food items that they do not produce. Processing adds value to cassavas and helps establish the link between consumers and farmers. Cassava and its products constitute local indigenous varietal foods that are

adapted to the local environment, and people who do not have access to these local diverse foods through own production support farmers through purchase.

Given the lower prices achieved for sales of cassava HYVs compared to local varieties, wider acceptance of HYVs among farmers could reduce the earnings that they generate from cassava sales and thus destabilise livelihoods, especially for women and for those farmers who depend mostly on cassava for income, which in turn will have implications for household food security since income from cassava is used to purchase the food items and high protein foods that farmers do not produce. Moreover, there is little likelihood that higher crop yields, if they were forthcoming, will lead to higher income. The effects of price incentives on crop production, or of increased volumes of crop sales on income are not well understood or very predictable. The socio-cultural, economic (differential access to income, income expenditure patterns), and agroecological factors of production are ignored in the economic models that are applied to African agriculture and market integration (Berry, 1984).

Any alterations to existing polyculture farming systems may lead to their simplification or to monoculture, and thus to a major reduction in crop diversity and the dietary diversity obtained. The consequences are a change in local dietary patterns, which may have negative consequences for nutritional diversity and security, food self-sufficiency, and security. Large scale, monoculture production of HYVs may increase *per capita* energy intake and offer economic benefits for producers as well as reduce costs of food for rural and urban consumers, but it clearly reduces dietary diversity and may have mixed impacts on nutritional status and therefore exacerbate rather than solve or reduce under-nutrition, food insecurity and non-communicable and communicable diseases. The costs entailed in substituting HYVs for local varieties are: high input and soil analysis costs that may not be compensated by the low prices obtained from surplus production, large scale production will increase the demand for labour in production, processing, and sale which will imply a tradeoffs for other livelihood activities; price decreases as a result of saturated markets; and land scarcity and therefore competition and conflicts over land between and within households, especially in Koudandeng where most households manage less than 1.5 ha of land.

8. A neglect of any of the parameters discussed below in policies that promote HYVs and fertiliser use may either undermine rural livelihoods and food security when they are widely accepted or, as is generally the case in the study area, households may not accept the inputs, but instead maintain their traditional foodways and food production systems, especially to meet their social obligations, earn an income, and achieve household food security. Experience from Asia, Central America and Mexico, and elsewhere in the world indicates that a shift from traditional polyculture farming systems to external-input based monoculture systems to facilitate HYV use, fertiliser application, and further market integration has been common among smallholders. The intended and unintended costs of such market-based agricultural intensification have often undermined traditional agroecological systems and eliminated their benefits. Some of the costs of such a shift include: i) mechanisation of agriculture with its associated risks; ii) increased pests and disease incidence due to the elimination of host plant/predator relationship which provides a microclimate that is suitable for the spread of pathogens (fungi and nematodes) and pests, which increases the risks of crop failure; iii) increased risk of spectacular crop failure; iv) an increase in the amount and cost of labour required for crop management; v) a reduction in dietary diversity and subsequent increase in the incidence of micro-nutrient deficiencies;

and vi) dependence on input and output markets which increases indebtedness and economic vulnerability.

African farm households' livelihood patterns represent the interplay of complex, dynamic, and diverse social, cultural, agroecological, and economic conditions and processes that influence households' food security status. A reductionist approach, which is often justified on the basis of aggregate agricultural production statistics that are erroneous at worst or unreliable at best, holds that the source of food insecurity is inadequate agricultural production, so the solution lies in transforming the productive capacity of African agriculture (Berry, 1984). The technologies that are proposed as the solution are biased by Western scientific theoretical models that are reinforced by the interests of international firms that manufacture the inputs required for this proposed radical transformation, or 'revolution'. The environmental and genetic parameters that are used to explain the performance of African farming systems are insufficient to account for the ways in which African agriculture is carried out. Berry (Ibid.) notes that environmental conditions define some of the parameters within which crop production takes place, but the development of more productive agricultural systems depends on how people exploit their environment. The implications of diverse African ecological conditions for cultivation are not well understood and therefore the technologies that are developed are often unsuitable and are either rejected by farmers, or only are only partially adopted. Rejection of technologies outright means that the investments realised in them are wasted, and alternative investments that may in fact be productive are not made. Partial adoption leads to only partial gains in productivity compared with those anticipated, or even to losses in productivity, unless farmers themselves are able to test and thus predict outcomes (as farmers in Malende have been able to do with the cassava HYVs they have adopted).

Policies that emphasize only food and income needs of rural households may act in detriment to environmental, socio-cultural, spiritual, and health values that are fulfilled by existing local varieties and cropping systems, which also inform how farmers perceive and relate to the natural, social, and spiritual worlds. Such policies may have negative implications for food security and well-being. Biological, socio-cultural, economic, and spiritual and health factors that shape farmers' decision making determine which cassava varieties they manage, and should be considered as a whole system and not in isolation when formulating food security and agricultural policies.

7.2.5 Alternative Parameters of African Farming Systems

Apart from satisfying nutritional and food security needs and earning an income, food crops in general and cassava in particular are grown in swidden polyculture systems for a multiplicity of reasons, including to meet social obligations, enhance male fertility, maintain cultural identity, provide spiritual values, manage labour supply, and deal with land constraints while maintaining agroecological integrity, and preserving and managing genetic diversity. Here it is proposed that three sets of parameters can be used to better understand and improve traditional African farming systems: agroecological, genetic, and socio-economic and cultural.

Agroecological parameters

- All of the factors that determine the agricultural potentials of an environment should be considered as a whole when judging the suitability of soils for agriculture and soil fertility improvement recommendations.
- Agricultural potentials must be assessed together with actual soil management practices (fallow lengths, nutrient demands of companion crops, use of crop residues and other organic matter, etc.) and outcomes to determine if, when, where, and why nutrient management may be inadequate, and what measures might be taken to deal with deficiencies. Assessment and proposed solutions must take into consideration intra-cultural diversity with respect to access to resources such as land, labour, and cash with which to purchase inputs. Such an assessment should occur at a scale that can account for such ecological and intra-cultural variation.
- Due to resource limitations, outsiders alone cannot adequately assess yields of polyculture systems. Farmers must be involved in any such assessment, and they must also be involved in identifying yield-related problems in their production systems as well as potential solutions.

Genetic parameters

- To the extent that Participatory Plant Breeding (PPB) programmes are useful and cost effective, they should approach crop varieties as specific cultural domains where the use of ethnobiological approaches is required to effectively capture the distribution of knowledge across farmer socioeconomic sub-groups, intra-cultural variation in varietal salience and farmers' perceptions of crop varieties, and relate these to farmers' practices (the varieties actually grown).
- In addition to yield and pest and disease resistance, the crop varietal characteristics that African farmers consider will nearly always include: i) foodways and dietary traditions, ii) food security (*vis a vis* maturation period, possibilities for piecemeal harvest, capacity to 'fill the stomach', etc.), iii) marketability; vi) storage and processing conditions and constraints, v) labour and land constraints, as well as ecological conditions in existing farming systems, and iv) spiritual, ritualistic, social exchange, medicinal, and heritage values. Since these are important in determining varietal selection and use across different groups of farmers, they also contributes to the maintenance of greater genetic diversity and low acceptance of HYVs.

Socio-cultural and economic parameters

- The biological (food, nutritional), cultural, economic, social, and spiritual factors that influence farmers' decision making frameworks in relation to their choice of crop varieties, which are intertwined in their livelihood strategies, should be understood and used as guiding principles for developing food security policies. All these must be taken into account when considering how farmers may respond to new technologies, while anticipating the existence of intra-cultural variation.
- African farm households have multiple goals and objectives, one set of which are related to meeting social obligations relating to kinship and patronage. People not only have access to food and other resources through own production and income,

but also through their social relations. Farmers confront trade-offs between meeting individualistic goals and social obligations. These should be considered simultaneously when defining food security policies.

- Culturally defined foodways, dietary patterns, and the associated storage and processing requirements and conditions orient traditional African farming systems and crop diversity and are central to the definition of the concept of food security. All must therefore constitute important parameters for food security policies and goals.
- The farm households' diverse income generation portfolio determines patterns of investment of cash, labour, and other inputs and are thus pivotal to understanding the implications of development policies that aim at increasing farmers' income through agriculture, and much more through individual crops. This implies understanding how agriculture fits into farm households' livelihoods. The specific social relations and cultural and historical contexts that influence farmers' judgements should be given greater consideration.
- Patterns of resource endowment (especially land tenure and land access, and access to labour) limit the acceptability of agricultural innovations especially for women household heads and landless farmers, who can also be the most food insecure.
- Consumer preferences for specific crops and crop varieties are largely determined by local foodways and dietary traditions, which also provide nutritional diversity. Extending food security to urban households should support rather than undermine local foodways and farming systems.

7.2 Policy Recommendations and Suggestions for Research

7.2.1 Policy Recommendations

AGRA and, implicitly or explicitly, the Cameroon Government and international institutions, are proposing to intensify and further commoditise what are often small-scale, subsistence-oriented traditional agricultural production systems across Africa. In arguing against this, the following are policy recommendations:

- AGRA and related government policies and programmes does not consider real African farming systems and real African farmers and how and why they function as they do which, it is argued, must serve as the point of departure for agricultural policies and programmes across the region if these are to succeed in supporting such farmers, their communities, and their nations. Farmers' culture, social relations, knowledge, practices, and experiences that remain, in the 'New' Green Revolution, as in the 'Old', a black box, should be reconsidered in policies and research and development. Agroecological systems, knowledge, and practices should be respected because Africans are embedded in traditional social relations and cultures, as well as diverse agroecosystems, to which their traditional farming practices are adapted. It is necessary to thoroughly understand how farmers' own ('emic') perspectives and experiences influence and are influenced by farming systems and agroecological conditions, how these underlie their choice of crops and crop varieties and their soil management strategies and techniques and, as well, how such perspectives and experiences are related to their cultures, moral economies, and to the respective political economies of their nations and continent. Many would argue that culture and local knowledge are among the main parameters that determine the nature and performance of African smallholder farming systems, their future sustainability, and the well being of rural people. However, this study has shown that AGRA's framework does not relate agroecology and farming systems to culture, but instead virtually ignores the latter, and analyses social relations and agroecology as though these were separate and unrelated entities.

- Greater consideration should also be given to the relationship between traditional farming systems, crop diversity, and nutrition diversity and security, and the implication for human health in policy formulation.

- Developing concrete methodological protocols that would facilitate understanding farmers' culture, social relations, knowledge, practices, and experiences, and how they interrelate is primordial for research and development.

- The production crop statistics that are used to characterise traditional African farming systems and therefore the African food problem should not be limited to cereal crops, which do not constitute the staple food of most African societies, but should include all of the food crops that these communities manage such as roots and tubers, legumes and oil seeds, plantain/banana, fruits and wild food plants, while emphasising the aggregate yields of these crops and the notion of Land Equivalent Ratio. This characterisation should account for the ecological and cultural diversity of African societies to facilitate the formulation of better food security policies and goals that are region specific rather than continental.

- In response to the question of whether breeding new crop varieties is the viable solution to the 'African food problem', given the high costs involved that limit the involvement of most African governments and farmers, the multiplicity of desired characteristics of crops and crop varieties, and the low acceptability of HYVs for farmers, greater effort should be directed at promoting farmer exchange of and experimentation with their rich diversity of crops and crop varieties. If breeding of new crop varieties is necessary at all, then participatory plant breeding efforts should be concentrated on breeding for the qualities that facilitate the attainment of farmers' objectives, rather than on yield and pests and disease susceptibility, which have to date largely guided crop breeding strategies.

7.2.2 Suggestions for Further Research

An analysis of the implications of AGRA-type recommendations that are implicit or explicit in government and research institutions' policies and goals for traditional African farming systems, livelihoods, food security, income and other goals that are important to African farmers on the basis of the case of two villages in Cameroon is not sufficient to make generalisations across Africa. Further, the breadth of the research topic and the financial and time constraints did not permit in-depth investigation into all the aspects of this research agenda, and so recommendations are made for further research that could give greater insights into the debate on technology and food security for Africa.

- Investigate whether population pressure as purported is actually the primary driver of poverty and food insecurity in Africa, or whether other primary drivers exist and to what extent they contribute to food problems at various scales.

- Further deepen the analysis of the diets that rural and urban African households consume and the nutritional value of such diets, considering the relation between dietary diversity, nutritional security, and biological diversity in the agroecological systems that supply such diets. Relate these as well to total household production (including homegardens, wild food, and polyculture fields), to social access to food, and to household expenditures on food purchases in order to detect problems with food security and nutrition.

- Investigate how farmers effectively participate in participatory plant breeding, the categories of farmers involved, and how the varieties bred fit with their socio-economic, cultural, spiritual, agroecological, and biological (nutrition) needs. Assess side-by-side programmes that promote exchange of farmer varieties to determine which result in higher adoption rates and better overall farming system performance.

- Soil maps of Europe show how badly the soil has been mined in many regions, but at least they are up-to-date and related to actual farming systems. The soil map of Africa should be upgraded to include all soils and their relationship with the diverse farming systems across Africa to facilitate a better characterisation of African farming conditions.

- If the use of fertilisers in African agriculture is desirable at all, than in-depth estimation of the nutrient requirements of companion crops in traditional African polyculture fields (including cassava-based fields) should be carried out if appropriate recommendations for the use of such inputs are to be made. Other means of enhancing soil fertility and the sustainability of soils should be explored before prescribing fertiliser use. When possible, fertilisers should be based on locally available resources rather than on imported, increasingly scarce resources, and more research should be focused on how to produce or procure such resources locally.

- Comparative analysis of aggregate yield data for traditional African polyculture fields and on root and tuber crop yields should be compared with yield data for monoculture fields of the same size and cropping density, which will enhance research orientations and policy recommendations.

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ANNEX C

CASSAVA PRODUCTION

(Respondent needed: All male and female household heads, wife /wives of HH head, all adult members of HH who manage separate cassava fields).
In this section, I would like to know more about cassava

Cassava Varietal Crop management in Field: (qualitative questions and answers).

Do you plant the different cassava varieties on specific fields? 1. Yes; 2. No

Variety	Why do you plant in specific fields?	Do you use any special method for planting each variety?					Specific pesticides and other chemicals used	What pest and disease problems per variety?	How do you solve each problem?
		Land preparation method	Plant material preservation method	Staking method	Planting distance (local measures if possible)	Cropping pattern			

For the pest and disease problems that you faced in growing the different cassava varieties in the last 12 months

Pest or disease problem	Period during which problem occurs	Extent of problem **Code A**	What were the symptoms?	What method did you use to solve the problem?	How much did it cost you to solve the problem? (frs.cfa)

Code A: Extent of problem: 1. Low**;** 2. Medium; 3. High

For the pest and disease problems that you faced in preserving (storing) the different cassava products that you processed and the harvested fresh roots of the different cassava varieties that you grew in the last 12 months

Product stored	Cassava varieties processed if not fresh roots	How did you preserve each product?	What pest and disease problem did you face?	What are the symptoms?	What methods did you use to solve the problem?	How much did it cost you to solve the problem? (frs.cfa)

Soil Conditions and fertility improvement

In the last 12 months, did the different cassava varieties require any special soil conditions for growing? 1. Yes; 2. No

Varieties	On what kind of soil conditions did you plant each variety? **Code A**	What problem did you face with each variety per soil condition?	How did you solve the problem?	How much did it cost you to solve the problem? (frs. cfa)

Code A: Kind of soil condition: 1. Poor soils; 2. Medium soils; 3. Rich or fertile soils; 4. other specify.

GENDER DIVISION OF ACTIVITIES IN CASSAVA PRODUCTION:

Gender Activity and Investment Matrix: For all the plots for which this person was responsible per season for the last 12 months.
Do you grow cassava in more than one season? 1. Yes; 2. No

Cassava Crop management in field for the 1st cropping season: Who within your household and the community carried out the following activities for you?

1. Main activity	2. Task	3. ID of person who was responsible for the task (multiple answers may be given)	4 Nos. of Plots	5. Apart from household members, did any one else help carry out task?					6. Was this done for payment of any kind? **Code A**
				5.1. Name/type of organisation or ID of household member	5.2. Relationship of person to you **Code B**	5.3. Age (yrs)	5.4. Sex	5.5. If group, how many people	
Land preparation	Bush clearing								
	Tree felling								
	Burning								
	Raking/trunk removing								
	Ridging/mounds								
	Other (specify)								
Planting	Plant material preparation/selection								
	Planting/transplanting								
	Replacement of plants that didn't sprout								
	Other (specify)								

1. Main activity	2. Task	3. ID of person who was responsible for the task (multiple answers may be given)	4 Nos. of Plots	5. Apart from household members, did any one else help carry out task?					6. Was this done for payment of any kind? **Code A**
				5.1. Name/type of organisation or ID of household member	5.2. Relationship of person to you **Code B**	5.3. Age (yrs)	5.4. Sex	5.5. If group, how many people	
Fertilisation	Manure/compost application								
	Chemical fertiliser application								
	Other (specify)								
Weeding	1st Weeding								
	2nd weeding								
	3rd weeding								
	Herbicide application								
	Other (specify)								
Pest and disease control	Setting traps against rodents/wild game								
	Pesticide/fungicide application								
	Other (specify)								
Harvesting and transportation	harvesting								
	Field to home transport								
	Other (specify)								

Code A: Was done for payment?: 1. for payment; 2. for labour exchange; 3. unpaid; 4. other (specify)
Code B: Relationship to you: 1. Neighbour; 2. Friend; 3. Other kin (specify); 4. Hired labour; 5. Labour exchange; 6. Individual; 7. Other (specify)

Cassava management in field for the 2nd cropping season: For all the plots for which this person was responsible.

Who within your household and the community carried out the following activities for you?

1. Main activity	2. Task	3. ID of person who was responsible for the task (multiple answers may be given)	4. Nos. of Plots	5. Apart from household members, did any one else help carry out task?					6. Was this done for payment of any kind? **Code A**
				5.1. Name/type of organisation or ID of household member	5.2. Relationship of person to you **Code B**	5.3. Age (yrs)	5.4. Sex	5.5. If group, how many people	
Land preparation	Bush clearing								
	Tree felling								
	Burning								
	Raking/trunk removing								
	Ridging/mounds								
	Other (specify								
Planting	Plant material preparation/selection								
	Planting/transplanting								

1. Main activity	2. Task	3. ID of person who was responsible for the task (multiple answers may be given)	4. Nos. of Plots	5. Apart from household members, did any one else help carry out task?					6. Was this done for payment of any kind? **Code A**
				5.1. Name/type of organisation or ID of household member	5.2. Relationship of person to you **Code B**	5.3. Age (yrs)	5.4. Sex	5.5. If group, how many people	
Planting	Replacement of plants that didn't sprout								
Fertilisation	Manure/compost application								
	Chemical fertiliser application								
	Other (specify)								
Weeding	1st Weeding								
	2nd weeding								
	3rd weeding								
	Herbicide application								
	Other (specify)								

1. Main activity	2. Task	3. ID of person who was re-sponsible for the task (multi-ple answers may be given)	4. Nos. of Plots	5. Apart from household members, did any one else help carry out task?					6. Was this done for pay-ment of any kind? **Code A**
				5.1. Name/type of organisation or ID of household member	5.2. Relationship of person to you **Code B**	5.3. Age (yrs)	5.4. Sex	5.5. If group, how many people	
Pest and disease control	Setting traps against rodents/wild game								
	Pesticide/fungicide application								
	Other (specify)								
Harvesting and transportation	harvesting								
	Field to home transport								
	Other (specify)								

Code A: Was done for payment?: 1. for payment; 2. for labour exchange; 3. unpaid; 4. other (specify)
B: Relationship to you: 1. Neighbour; 2. Friend; 3. Other kin (specify); 4. Hired labour; 5. Labour exchange; 6. Individual; 7. Other (specify)

If you paid for labour in total for all plots

ID No. person who paid	Who was paid **Code A**	If in Kind payment,				If in cash payment,	
		What paid	For what **Code B**	Quantity	Unit	Amount	Unit

Code A: Who was paid: 1. Hired labour; 2. Neighbour; 3. Friend; 4. Other household member (only cash not food) Specify ID
Code B: For what paid: 1. Land preparation (specify tasks); 2. Planting (specify tasks); 3. Fertilisation (specify tasks); 4. Weeding (specify tasks/season); 5. Pests/disease control (specify tasks); 6. Harvesting and transportation (specify tasks and transport location); 7. Other (specify)

Chemical and other Inputs

I would like to talk about the input requirements of the different cassava varieties that you grew in the last 12 months

Did any cassava variety require the application of special chemicals? 1. Yes; 2. No.

Field type	Plot No.	input applied **Code A**	On which specific cassava varieties did you apply?	At what cost?	
				amount	unit

Code A: Input applied: 1. Fertilizer; 2. Pesticides; 3. Fungicide; 4. Herbicide; 5. Other chemical input (specify) 6. Compost manure; 7. Green Manure (grass buried in ridges/mounds etc); 8. Household refuse; 9. Animal waste product (specify); 10. Other (specify)

Farm and Processing Inputs

Farm tools and equipment

What farm tools and equipment did you use in cassava production in the last 12 months?

Activity	Tools/equipment	Do you own? 1. Yes; 2. No	If yes,		If No, how did you get it?	
			How did you get it? **Code A**	How long ago?	Person or organisation	Relationship to you
Crop Management in field						
Harvesting/ transport						
Processing						
Storage						

Code A: How got it: 1. bought; 2. a gift; 3. Other (specify)

Do you belong to any organisation from which you obtain services of inputs and equipment for cassava production? 1. Yes; 2. No.

Type of Organisation **Code B**	Why do you belong?	Who are the members?	What did you get from it? (Multiple answers may be given) **Code A**	If you got anything for what purpose?	What conditions did you fulfil to obtain the thing?

Code A: What did you get: 1. credit; 2.Farm tools/equipment (specify); 3. Fertilizers; 4. Pesticides; 5. Fungicides; 6. herbicides; 7. Other chemical inputs (specify); 8. Labour exchange; 9. Other (specify)

Code B: Type of organisation: 1. Njangi or tontine; 2. Labour exchange group; 3.Producer Association or organisation; (specify if :a. unregistered; b. registered (specify if CIG, EIG); 4. Professional Producer Association (PPA); 5. Union of Professional Producers Association; 6. Federation of Professional Producers Association; 7. Church Group (specify); 8. Village Development Committee; 9. Village or ethnic Group Meeting; 10.Cassava plant material 11. Other (specify)

Cassava Plant Material

In the last twelve months, how did you obtain cassava plant material to plant? (list each variety per line.)

Variety planted	How much did you plant?	Source **Code A**	If gift,		If purchased, cash payment					If exchanged,		If own fields, how much?
			From who	How much received	From who	How much paid				With whom **Code B**	How much	
						Qty	Unit	amount	unit			

Code A: Source: 1. Own fields; 2. Purchased; 3.Gift; 4. Exchanged; 5.other (specify)

Code B: With Whom: 1. Friend; 2. Woman in village; 3. Man in village; 4. Mother; 5. Father; 6. Mother-in-law; 7. Sister-in-law; 8. Brother-in-law; 9. Father-in-law; 10. Other kin (specify); 11. Other (specify)

In the last month, of what you harvested from your fields, who in this household processed cassava (not helped to process but processed on their own, perhaps with someone helping them)?

Person ID who processed in household	What Products?	How many times processed in the last month?	ID of household member who assisted	Who outside Household participated? **Code A**	Was this unpaid? 1. Yes 2. No	What quantity was processed each		How much was eaten?		How much was sold?		For the quantity sold, who got the money?	Did you use outside services for processing for payment of any kind?
						Quantity	Unit	Quantity	Unit	Quantity	Unit		

Code A: Who outside HH participated: 1. Female neighbour; 2. Friend; 3. Male neighbour; 4. Hired labour; 5. Other kin (specify); 6. Other (specify)

In the last month, did you buy cassava to process or to consume? 1. Yes; 2. No

If yes, which form/product did you buy?	How many times did you buy?	What quantity?	Unit	Why did you buy?	If you bought fresh roots, what varieties?	Which form/product did you buy?	How many times did you buy?	What quantity	Unit	Why did you buy?	If you bought fresh roots, which varieties?

If you used outside services for processing for payment in the last month that you paid;

Product	Who did it?			How many times?	How much processed in total?		Who paid?	What was paid each time? **Code B**	How did you pay? **Code C**	If in kind payment			If cash payment	
	Relationship of person who pro-cessed to you (**Code A**)	Age (yrs)	Sex		Qty	Unit				Nature	qty	unit	Amount	Unit

Code A: Relationship to you: 1. Friend; 2. Female neighbour; 3. Male neighbour; 4. Hired labour; 5. Other kin (specify); 6. Other (specify)
Code B: What paid: 1. for in kind payment; 2. for cash payment; 3. for labour exchange; 4. unpaid; 5. other (specify)
Code C: How did you pay: 1. Per hour; 2. Per day’s work; 3. Per unit product processed; 4. Other specify

For each product that you processed, did you process for consumption or for sale? 1. for sale; 2. for consumption

In the last month, did you process less or more than usual?

If so, why?

If so, how much more or less per product?

Seasonality of processing

Compared to the last month, are there times in the last 12 months that you had to process more or less cassava harvested from own fields or purchased? 1. Yes; 2. No.

Follow calendar backwards from the month of interview.

Reason for extra processed	Product Processed	Did you use any special varieties (specify)?	January		February		March		April		May		June	
			Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit

Reason for extra processed	Product Processed	Did you use any special varieties (specify)?	July		August		September		October		November		December	
			Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit

For each product that you processed, did you process for sale or consumption? 1. for sale; 2. for consumption

Cassava Sales

In the last month, did you sell cassava in any form or cassava leaves? 1. Yes, No.

If you did not sell in the last month, how often do you sell cassava or cassava leaves in the last six months?

If you sold cassava in the last month;

Product/Form	How much sold?			1st Sales Market Point			2nd Sales Market Point			3rd Sales Market Point			Total sales in the last 6 months			Total Sales in the last 12 months	
	Qty	unit	Price per unit	Location/Name	Amt sold	Unit	Location /Name	Amt sold	Unit	Location/ Name	Amt sold	Unit	Qty	unit	Amt frs. cfa	Qty & unit	Amt frs. cfa
Cassava leaves																	
Fresh roots Local varieties																	
Fresh roots research /agric varieties																	
Total fresh roots																	
Product A: 1. Research /agric varieties																	
2. Local varieties																	
Total Product A																	

Product B: 1. research/agric varieties																	
2. Local varieties																	
Total Product B																	
Product/Form	How much sold?			1st Sales Market Point			2nd Sales Market Point			3rd Sales Market Point			Total sales in the last 6 months			Total Sales in the last 12 months	
	Qty	unit	Price per unit	Location/Name	Amt sold	Unit	Location /Name	Amt sold	Unit	Location/ Name	Amt sold	Unit	Qty	unit	Amt frs. cfa	Qty & unit	Amt frs. cfa
Product C: 1. Research/agric varieties																	
2. Local varieties																	
Total Product C																	
Product D: 1. Research/agric varieties																	
2. Local varieties																	
Total Product D																	

For the markets you mentioned, tell me which you prefer? Why?

In general, which markets are expensive?

In general, which markets are difficult for you to have access?

How much do you pay to transport your cassava produce to each market?

What other charges (expenses) do you incur in the different markets?

Are there any reasons why you do not go to any other markets?

Would you prefer to sell at any other market? If so, which markets? If so, why?

Seasonality of Sales

Compared to the last month, are there times in the last 12 months that you had to sell more or less cassava harvested from own fields or purchased? 1. Yes; 2. No.

Follow calendar backwards from the month of interview.

Reason for extra or less sales	Product sold	Did you use any special varieties (specify)?	January		February		March		April		May		June	
			Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit

Reason for extra or less sales	Product sold	Did you use any special varieties (specify)?	July		August		September		October		November		December	
			Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit	Amt extra	unit

Marketing of different varieties

Comparing the traditional and research /agric cassava varieties, which ones fetch, better prices? Why?

Are there certain markets where different cassava varieties fetch better prices? Why?

Which cassava varieties do you prefer to sell?

i) Fresh? Why?

ii) Leaves? Why?

iii) Processed product A? Why?

iv) Processed product B? Why?

v) Processed product C? Why?

vi) Processed product D? Why?

In general, is this preference the same for all varieties throughout the year? Why?

Gender activity and investment matrix: Cassava Sales in the last month.

In the last month, did any one assist you to sell the different forms of cassava or leaves that you sold? 1. Yes; 2. No.

If yes, what form or products were sold?	Did any one assist you in selling in the last months?				
	ID of household member	If person outside household, state relationship to you **Code A**	Age (yrs)	Sex	Was this done for payment of any kind? **Code B**
Cassava leaves					
Plant material					
Product A					
Product B					
Product C					
Product D					

Code A: relationship to you: 1. Friend (specify female or male); 2. Female neighbour; 3. Male neighbour; 4. Hired labour; 5. Other kin (specify); 6. Other (specify).

Code B: Payment in any kind: 1. for payment; 2. for labour exchange; 3. unpaid; 4. other (specify)

For those who helped you in selling for payment, what did they sell?

	Tasks paid for	How did you pay? **Code A**	How much cash did you pay in the last month		If cash payment, about how much in total did you pay for the last 12 months?		If in kind payment,		
			amount	unit	amount	unit	What did you pay?	Qty	unit

Code A: How did you pay: 1. Hourly; 2. Per day’s work; 3. Per unit product processed; 4. Other specify

Credit in Cassava:

In the last twelve months, did you obtain credit (a loan) to use in growing, transporting, processing or selling cassava? 1. Yes, 2. No.

If yes, from whom? **Code A**	Why?	How much did you get?		What conditions did you fulfil to obtain the loan?	At what interest rate?	How much still owed?	For how long was the loan?
		Amount	Unit				

Code A: From whom: 1. Friend (specify male or female); 2. female neighbour; 3. Male neighbour; 4. Savings and loans/njangi group; 5. formal organisation (specify); 6. Money lender in village; 7.Household member (specify ID); 8. Other kin (specify); 9. Other (specify).

Other Income Sources in Cassava

Apart from cassava sales, did you carry out any activity related to the cultivation, transport, harvesting, processing, storage and sales of cassava to earn an income in the last 12 months? 1. Yes; 2. No.

Activity	How many times did activity in the last 12 months?	Months during which activity was done	What kind of payment did you receive? Code A	If in kind payment			If cash payment		About how much in total did you receive in the last 12 months?
				What did you receive?	Qty per time	Unit	amount per time	Unit	

Code a: kind of payment: 1. Cash; 2. In kind payment; 3. Labour exchange; 4. other (specify).

Income Expenditure/investment: Exclude expenditure made on cassava cultivation, processing, storage and sales)
Apart from making labour payments for the production, harvesting, transport, processing and sales of cassava, what did you do with the money earned from your cassava sales in the last 12 months?

Expenditure head (item)	How many times spent on item in the last 12 months	Months during which spent on item	Why did you make the expenditure?	About how much did you spend in the last 12 months?	
				Amount	Unit

ANNEX D

HEALTH MODULE

Health Status Identification: Respondent needed: Male and female household head, wife or all the wives in case of polygamy, any adult member of the household.

In this section, I would like to talk more about the health status of all the members of your household, the illnesses and related treatments that they have had in the last 5 years and the deaths that have occurred within your household in recent years.

I. HOUSEHOLD DEMOGRAPHICS:

Do you have children of your relations living in your household? 1. Yes; 2. No

Table 1. Children of other relations living within household

Identification number of child	Relationship of child to household head	How long has the child lived in this household?	Have any of the parents of this child died? 1. Yes; 2. No	If died, which of the parents? 1. Mother 2. Father 3. **B**oth	How long is it since they died?	What was the cause of their death? If illness, specify the type.	If illness, what were the symptoms?	For how long were they sick before dying?	Where did they receive treatment before dying? (If in a hospital, specify the name and location)

II. ILLNESS:

In the last 5 yeas, who within your household suffered from any prolonged or repeated illnesses?

Table 2: Illness of household members.

Identification number of person	Type of illness the person is suffering from	Name of illness in your local language	What are the symptoms of this illness?	What is the probable cause of this illness?	How long has the person been ill?	Where is the person receiving treatment? If hospital, specify name and location	How much has the treatment cost?	Who paid or is paying for the treatment?	Who is taking care of the patient? i.e. washing of clothes, providing food etc.

Table 3: Illness diagnosed

Has any member of your household been diagnosed to suffer from any of the following illness in the last five years?

Identification number of person	Illness suffering or suffered from Code A	What are the symptoms?	How long has the person suffered from the illness?	What is the cost of the treatment?	Who is paying for the treatment? Specify relationship to the patient	Where is the person receiving treatment? Specify name and location.	Why did the person choose to receive treatment in a particular place?	Who took care or is taking care of the patient? i.e. washing of clothes, providing food etc.

Code A: illness suffering from: 1. Cancer (specify on which part of the body); 2. Tuberculosis (specify on which part of the body); 3. Typhoid fever; 4. Recurrent malaria (every month etc.); 5. Skin rashes or dermatitis; 6. Skin and hair/head fungi; 7. Hair falling off; 8. Prolonged diarrhea; 9. Constant headache; 10. Anemia; 11. slow poison; 12. Syphilis; 13. Gonorrhea and other infections; 14. Hepatitis; 15. Other (specify)

Table 4: Membership in health associations and ability to carry out agricultural work

Identification number of person who is sick	Is the patient a member of a health association? specify name and location	Who else in your household is a member of a health association? specify name and location	Why does the patient or other member of the household belong to the health association?	What has the patient or other member received from this association?	Does the patient do any agricultural work? iv) Yes v) No	What field types is the patient managing?	What are the major crops grown per field type?	What is the distance of each field type? 1. <10 min. 2. 10 – 30min 3. 30 – 60 min 4. > 60 min

III. DEATHS WITHIN HOUSEHOLDS:

Has anyone in your household died in the last five years? 1. Yes; 2. No

Table 5: Infant deaths

Name of infants born alive in the last five years	Did anyone die? 1. Yes; 2. No	Age of the child be-fore death	Of what illness did the child die ?	What were the symptoms of the illness?	Where did the child receive treatment?	Why did the parents choose a specific treatment location?	How much did the treat-ment cost?	Who paid for the cost of the treatment?	Who paid for the funeral expenses?	Who took care of the sick child?

Table 6: Adult Deaths

Name of adult who died in the last 5 years	Relationship of the dead person with the house-hold head	Age before death	Of what illness did the person die? (local names also possible)	What were the symptoms of the illness?	Where did the person receive treatment?	Why did that person choose to be treated in a particular place?	How much did the treatment cost?	Who paid for the treat-ment?	Who paid for the funeral expenses	Who took care of the person before his/her death?

Name of adult who died	Did the person who died belong to any health association? (give name and location)	Why did he/she belong to this association?	What did the dead person receive from the association?	Did the dead person do any agricultural work before death? 1. Yes; 2. No	What and how many field types many did he/she manage?	What were the major crops grown in each field type?	What is the dis-tance of each field type? 1.<10 min 2. 10 – 30 min 3. 30 – 60 min 4. > 60 min

ANNEX F

FREELISTING AND FOLLOW-UP RESEARCH INSTRUMENT

Dimensions of knowledge in cassava to be investigated in Muyuka and Obala (Questions to individual farmers)

Geographical Sample Identification	Informant Identification	
Results (fill out in pencil):		
Province___________________	Number_____________	Complete______________
Division___________________	Name_______________	Incomplete____________
Sub Division_______________	Sex______________	Rejected______________
Village____________________	Age (years)__________	Absent________________

I. Varietal Knowledge

1.1. Please, list all the different cassava varieties that you can think of. Include those that you grow and do not grow (Local names are required if possible)	1.2a. Varieties currently grown 2005	1.2b. If not currently grown, have you ever grown this variety?	1.3. Why do you grow those currently planted?	1.4. Source of current planting material grown (If from persons, indicate relationship with you, town or village where the person resides.	1.5. For those varieties that you grew previously in the past but are not currently growing: a) When did you last grow this variety? b) Why are you not growing it this year?	1.6a) For those varieties which you have never grown, how did you learn about them?	1.6b) Why have you never grown them?	1.7. Rate yourself on the ability to recognise the different cassava varieties if presented to you. Rating Scale 1. Poor 2. Fair 3. Good 4. Very Good 5. Excellent
1	Y N	Y N						
2	Y N	Y N						
3	Y N	Y N						
4	Y N	Y N						
5	Y N	Y N						
6	Y N	Y N						
7	Y N	Y N						
8	Y N	Y N						
9	Y N	Y N						
10	Y N	Y N						
11	Y N	Y N						
12	Y N	Y N						

Varietal distribution by field type knowledge: Men's field types

2. Please, list all the different field types managed by men (local names are required if possible)	2.1. How many of these cropping systems do you currently have in the field?	2.2. Are these major or minor fields? 1. Major 2. Minor	2.3. Are these 1^{st} of 2^{nd} season fields	2.4. What is the approximate size of each field type? Local measures may be used.	2.5. Why do you mange specific field types	2.6. List all the crops grown in this field type in descending order of importance	2.7. What is the fallow rotations that are preferred?	2.8. What are the characteristics of the ideal fallow for this cropping system?
1			___1^{st} ____2^{nd} ___Both					
2			___1^{st} ____2^{nd} ___Both					
3			___1^{st} ____2^{nd} ___Both					
4			___1^{st} ____2^{nd} ___Both					
5			___1^{st} ____2^{nd} ___Both					

6			___1st ____2nd ___Both					
7			___1st ____2nd ___Both					
8			___1st ___2nd ___Both					
9			___1st ____2nd ___Both					
10			___1st ____2nd ___Both					
11			___1st ____2nd ___Both					
12			___1st ____2nd ___Both					

Field types managed by men

Field types managed by men	2.9. What is the preferred soil characteristics (most suitable) of each field type	2.10. What is the characteristics of the field type you are currently managing	2.11. What is the preferred location for each field type? Why	2.12. Where is your field type located	2.13. How many months after planting is the last crop harvested	2.14. Which cassava variety do you grow in each field type? Why?
1						
2						
3						
4						
5						
6						
7						
8						

Example of field type: esep or epak fields which are major men’s fields, the afub bikoro which are yam fields, afub owondo which are groundnut fields as well as women’s main food crop fields in the typical subsistence farming system of the Etone tribe; afub mebanghe which are cocoyam fields; afub meboura which are sweet potato fields; afub mbas which are maize fields; afub elobi which are market garden crop fields which are managed in marshy areas also called Lamba in South West province.

2.3. Which of the field types do you use as home gardens? Why?
Varietal distribution by field type knowledge: Women's field types

2. Please, list all the different field types managed by women (local names are required if possible)	2.1. How many of these cropping systems do you currently have in the field?	2.2. Are these major or minor fields? 1. Major 2. Minor	2.3. Are these 1st of 2nd season fields	2.4. What is the approximate size of each field type? Local measures may be used.	2.5. Why do you mange specific field types	2.6. List all the crops grown in this field type in descending order of importance	2.7. What is the fallow rotations that are preferred?	2.8. What are the characteristics of the ideal fallow for this cropping system?
1			___1st ____2nd ____Both					
2			___1st ____2nd ____Both					
3			___1st ____2nd ____Both					
4			___1st ____2nd ____Both					
5			___1st ____2nd ____Both					
6			___1st ____2nd ____Both					

7			___1st ____2nd ____Both					
8			___1st ____2nd ____Both					
9			___1st ____2nd ____Both					
10			___1st ____2nd ____Both					
11			___1st ____2nd ____Both					
12			___1st ____2nd ____Both					

Example of field type: esep or epak fields which are major men's fields, the afub bikoro which are yam fields, afub owondo which are groundnut fields as well as women's main food crop fields in the typical subsistence farming system of the Etone tribe; afub mebanghe which are cocoyam fields; afub meboura which are sweet potato fields; afub mbas which are maize fields; afub elobi which are market garden crop fields which are managed in marshy areas also called Lamba in South West province.

2.3. Which of the field types do you use as home gardens? Why?

Field types managed by women

Field types managed by women	2.9. What is the preferred soil characteristics (most suitable) of each field type	2.10. What is the characteristics of the field type you are currently managing	2.11. What is the preferred location for each field type? Why	2.12. Where is your field type located	2.13. How many months after planting is the last crop harvested	2.14. Which cassava variety do you grow in each field type? Why?
1						
2						
3						
4						
5						
6						
7						

2.4. Which cassava varieties do you grow on each field type?

Field type	2.4.1 Cassava varieties grown	2.4.2. Why are you growing these specific varieties on each field type?	2.4.3. How do you decide how much cassava to plant on each field at the beginning of each crop season?	2.4.4. How do you decide what quantity of each cassava to plant in each field type?	2.4.5. What quantity of cassava do you expect to harvest for each field type?	2.4.6. Do any of these field types cause differences in the quality of a given variety? What is due to?	2.4.7. Which cassava varieties are eaten or sold per field type?
1							Eat Sell
2							Eat Sell
3							Eat Sell
4							Eat Sell
5							Eat Sell
6							Eat Sell
7							Eat Sell
8							Eat Sell
9							Eat Sell

2.5. Is there any reason for the observed differences in the quantity and quality of the cassava harvested per field type? (probe with soil fertility/type reasons)

2.6. Is there any reason why you sell or eat specific cassava varieties that are harvested from each field type?

Dissertation Summary

The Alliance for a New Green Revolution in Africa and African government and CGIAR programmes oriented toward improving cassava production through intensification and the use of external inputs have the ultimate goals to improve food production, promote market integration, and increase incomes of small farm households. Essentially, AGRA's arguments, which are either implicit or explicit in the policies and programmes of the Government of Cameroon and of several CGIAR institutes that the Government collaborates with, are that traditional farming systems and practices suffer from low productivity and are unsustainable. African soils are naturally poor, farmers use little or no fertiliser, and the fallow periods that, in the past, provided for nutrient recycling, are declining due to population pressure, leading farmers to mine the soil, which results in declining crop yields. Further, farmers' local varieties are low yielding and are highly susceptible to pests and diseases compared to improved, high-yielding varieties (HYVs). Across Africa, per capita food production is declining, and families live in poverty and hunger. Population pressure is increasing, farmers are poor and thus in need of additional income and, if given the opportunity, they will seek to maximise their income from crops sales, which they in turn will reinvest in agriculture, given the right incentives. Farm households are food insecure and, by increasing their output and sales, they will become food secure.

This dissertation challenges these underlying assumptions and questions the underlying parameters individually and as a whole by examining traditional and more commercial smallholder cassava agroecological systems and households in two study sites in rural Cameroon (where conditions are theoretically quite positive for the acceptance of such technologies) from agroecological, ethnobiological, economic, and cultural perspectives. The objective is to understand the implications of policies and programmes that promote Green Revolution-type technologies and market integration for the productivity and sustainability of such agroecological systems, for the conservation of crop genetic resources, and for the livelihoods, income, and food and nutritional security of smallholder farm households. The intention is to critically examine the assumptions and underlying parameters posited by AGRA, and to reformulate these on the basis of the findings to provide a more adequate framework for approaching and assessing agricultural innovations in the African context.

The following questions orient the research: Are African farming systems, and farmers, characterised by attributes that AGRA ascribes to them? Are such farmers likely to accept the technologies that AGRA is promoting? Are AGRA technologies and strategies likely to lead to more sustainable, higher yielding farming systems? Are they likely to translate into greater market integration, higher incomes, greater food security, and renewed investment in agricultural intensification for small farm households? Are there trade-offs that farmers and their households and communities have to confront in adopting such technologies and, if so, how might these influence their strategies and responses to programmes that promote Green Revolution-type intensification of the 'old' or 'new' varieties?

Findings presented in this dissertation show that Koudandeng and Malende farmers have barely accepted Green Revolution technologies and modern farming strategies and systems (including monoculture). The analysis of the findings proposes reasons for this, and attempts to explain farmers' and households' production systems and strategies from an emic (farmers') perspective. It is argued that, if African farmers do not accept the Green

Revolution-type technologies, or accept them only on their own terms and in accordance with the outcomes that they themselves desire that differ significantly from what governments and researchers and donors anticipate, then this may be attributable at least in part to the fact that the strategies and technologies that are promoted are based on erroneous assumptions, not least about the key parameters that define the performance of real African farming systems and real African farming households. These parameters are grouped under two main categories - agroecological and socio-economic – which, in AGRA's discourse, are treated as if they were unrelated. There is thus an absence of attention to the relations between the agroecological (or what can be termed environmental, or 'nature'), and the socioeconomic (or what can be termed 'culture'), which in turn leads to an inattention to the diversity of cultures and agroecologies across Africa – its biocultural diversity – that permits blanket recommendations to be made on the basis of over-generalised and over-simplified assumptions.

When emphasising the need to give greater consideration to the relations between culture and nature – that is, to the diversity of African cultures, agroecologies, and socioeconomic systems and relations, and to the relations between culture, agroecology, and socio-economics - this dissertation proposes three different interacting sets of analytical parameters that must be considered if insights into real African agriculture and real African farm households are to emerge. Two of these sets of parameters emerge from a critique of AGRA's parameters and a third arises out of a framework for assessing the acceptability of crop varieties that has its foundations in ethnobiology.

This comparative research, which was carried out between 2002 and 2008, involved a total of 206 farmers in two different villages in two regions in the South of Cameroon. The methods for collecting and analysing data were both quantitative and qualitative, and were drawn from sociology, anthropology, and ethnobiology (cognitive anthropology). Qualitative data collection methods included a review of grey and published literature, as well as ethnographic interviewing and participant observation. Quantitative methods included four closed question surveys and cognitive ethnobiological elicitation (freelisting and triads testing). Qualitative interview data were coded and analysed narratively (description, explanation, interpretation, quotations) using Microsoft Word. The small household sample size that was used did not permit the use of sophisticated statistical analyses according to population sub-samples, which limited the analysis of survey data to that which would be done using descriptive statistics, such as proportions, percentages, and frequencies. Regression analysis was done sparingly. Cultural consensus analysis, proximities analysis, multidimensional scaling, quadratic assessment product, cluster analysis, and property fitting regression were used to analyse the ethnobiological data that was collected.

The general conclusions of this dissertation assert that traditional African polyculture systems and their genetic diversity (crop species and varieties) are often environmentally sustainable, able to meet income and food needs of rural households and communities, and fulfil multiple cultural needs relating to identity, foodways, spirituality, and social reciprocity. The assumptions behind the promotion of AGRA-type technologies are reductionist; they do not take into consideration the complexities of African agriculture and livelihoods, or the interrelation between farmers' social and cultural norms, resource access, and livelihood strategies, and how they carry out agriculture (e.g. spatial and temporal configurations, cropping patterns, crop and varietal choices, cultural practices). Across most of Africa, smallholders and their agroecosystems are firmly embedded in ethnic and tribal communities that adhere more or less strongly to cultural norms, beliefs, and kinship or lineage-based social relations. Their agricultural knowledge and practices are often based largely on local knowledge and resources. Such 'traditional' agricultural systems generally represent a long-term adaptation between culture and nature, where both have co-evolved over time. Farmers' knowledge and practices are embedded in social relations where many modes of subsistence are characterised by forms of communalism that are relatively egalitarian, which tends to ensure that resources are distributed in such a way that people have sufficient means to meet socially defined, as well as biological needs. Unsustainable practices and inegalitarian social relations that may accompany the adoption of Green Revolution technologies and greater market integration are likely to be mal-adaptive over the long run.

The assumptions underlying the 'New Green Revolution for Africa' drastically over-simplify traditional African farming systems and ignore their diversity and thus do not hold everywhere in Africa which, it is argued, may represent yet another threat to the integrity of traditional African cultures, agroecological systems, and biological diversity. Eight major critiques of this over-simplification and the resultant dangerous consequences for African farm households include: i) the inappropriateness (technical and practical limitations) of the recommendations for integrated soil fertility management practices and fertiliser use for most African contexts; ii) the lack of consideration for farm households' social constraints: differential access to income, land, and labour, and investments in other livelihood activities that compete with investments in agricultural inputs, which consequently may have implications for soil fertility management; iii) the lack of attention to the pests and diseases of most significance to farmers; iv) the relative inattention to the need to develop varieties that conform with local foodways and food processing and storage conditions; v) the implications of mass production of the reduction of crop diversity and varietal diversity for food security and nutrition and the consequences for human health; vi) the lack of serious consideration of farmers' knowledge and practices in crop breeding strategies and the lack of precise methodologies for effectively and systematically accessing and document farmers' varietal knowledge, perceptions, and preferences and relating these to farmer behaviour when accepting crop varieties; vii) the improbability that prices for mass produced HYVs will increase income and investments in inputs; and viii) the consequences of conversion to monoculture for livelihood and food security that are entailed in widescale acceptance of AGRA-type recommendations.

Based on these critiques, the major policy recommendation emphasised in this dissertation is to give greater consideration to real African farming systems and real African farmers and how and why they function as they do, which, it is argued, must serve as the point of departure for agricultural policies and programmes across the region if these are to succeed in supporting such farmers, their communities, and their nations. Farmers' culture, social relations, knowledge, practices, and experiences that remain, in the 'New' Green Revolution, as in the 'Old', a black box, should be newly considered in policies and research and development as positive points of departure for increasing food security in Africa.

Samenvatting van de dissertatie

De programma's van de *Alliance for a New Green Revolution in Africa* en die van Afrikaanse regeringen en het CGIAR gericht op verbetering van de cassaveproductie door intensivering en het gebruik van externe input, hebben uiteindelijk ten doel de voedselproductie te verbeteren, marktintegratie te bevorderen, en het inkomen van kleine boerenhuishoudens te verhogen. In essentie zijn de argumenten van AGRA im- of expliciet opgenomen in het beleid en de programma's van de regering van Cameroen en die van diverse CGIAR instellingen waarmee die regering samenwerkt. Deze argumenten komen erop neer dat traditionele landbouwsystemen en -praktijken lijden onder lage productiviteit, en dat zij niet duurzaam zijn. Afrikaanse bodems zijn van nature arm, en boeren gebruiken weinig of geen kunstmest. De periodes waarin de akkers braakliggen, voorzagen voorheen in recycling van voedingsstoffen. Maar onder de druk van bevolkingstoename worden die periodes korter, hetgeen boeren ertoe brengt de grond uit te putten waardoor de oogsten afnemen. Voorts hebben in vergelijking tot verbeterde variëteiten met een hoge opbrengst (HYVs, High Yielding Varieties), de lokale variëteiten van de boeren een lage opbrengst en zijn ze zeer gevoelig voor schadelijk ongedierte en ziekten. Vrijwel overal in Afrika neemt de voedselproductie per hoofd van de bevolking af, en lijden gezinnen armoede en honger. De bevolkingsdruk neemt toe, boeren zijn arm, en hebben dus aanvullend inkomen nodig. Als ze de kans krijgen, zullen ze streven naar het maximaliseren van hun inkomen door middel de verkoop van hun gewassen. Indien de omstandigheden motiveren genoeg zijn, wordt dit inkomen normaliter weer geïnvesteerd in de landbouw. Boerenhuishoudens zijn niet zeker van voedsel; door toename van hun productie en omzet zullen ze meer zekerheid in kunnen bouwen.

Deze dissertatie tart zulke onderliggende aannames en zet vraagtekens bij de onderliggende parameters, zowel afzonderlijk als tezamen. Vanuit diverse perspectieven - agro-ecologisch, ethnobiologisch, economisch en cultureel – worden traditionele en meer commerciële agro-ecologische systemen en huishoudens van kleine cassaveboeren op twee studielocaties in landelijk Kameroen belicht. Theoretisch bezien zijn deze locaties nogal positief voor aanvaarding van de door AGRA gestimuleerde technologieën. Het doel van deze studie is de implicaties te begrijpen van beleid en programma's die technologieën en marktintegratie van het type Groene Revolutie bevorderen, met name de gevolgen voor: i) de productiviteit en duurzaamheid van zulke agro-ecologische systemen, ii) het behoud van gewas-genetische hulpbronnen, en iii) het levensonderhoud, het inkomen en de voedselkwaliteit en kwantiteit van huishoudens van kleine boeren. De bedoeling van deze dissertatie is een kritisch onderzoek naar de door AGRA geponeerde aannames en onderliggende parameters, en deze op basis van de onderzoeksresultaten te herformuleren, om te komen tot een meer adequaat raamwerk voor het benaderen en bepalen van landbouw-innovaties in de Afrikaanse context.

De volgende vragen oriënteren het onderzoek: worden Afrikaanse agrarische systemen en boeren gekenmerkt door eigenschappen die AGRA aan hen toeschrijft? Is het waarschijnlijk dat zulke boeren de technologieën zullen aanvaarden die AGRA bevordert? Zullen AGRA technologieën en strategieën waarschijnlijk leiden tot duurzamere agrarische systemen met een hogere opbrengst? Is het waarschijnlijk dat deze zich zullen vertalen in een sterkere marktintegratie, hogere inkomens, toegenomen voedselzekerheid en hernieuwde investering in de intensivering van de landbouw voor de huishoudens van kleine boeren?

Worden boeren, hun gezinnen en gemeenschappen geconfronteerd met compromissen bij het overnemen van zulke technologieën, en zo ja, welke invloed zouden deze kunnen hebben op hun strategieën en responsen op programma's van het Groene Revolutie type welke intensivering voorstaan van de productie van 'oude' of 'nieuwe' variëteiten?

Resultaten in deze dissertatie tonen dat Koudandeng en Malende boeren Groene Revolutie technologieën en moderne agararische strategieën en systemen (inclusief monocultuur) nog nauwelijks hebben geäccepteerd. De analyse van de resultaten stelt redenen voor, en poogt productiesystemen en strategieën van boeren en huishoudens te verklaren vanuit een *'emic'* (boeren) perspectief. Indien Afrikaanse boeren de technologieën van het Groene Revolutie type niet accepteren, of die slechts accepteren op hun eigen voorwaarden en in overeenstemming met de uitkomsten die zij zelf wensen (en die dus duidelijk verschillen van de verwachtingen die regeringen, onderzoekers en donoren hebben), dan zou dit deels kunnen worden toegeschreven aan onjuiste aannames die de door AGRA gepromote strategieën en technologieën ondersteunen. Niet in de laatste plaats geldt dit voor de aannames ten aanzien van de sleutelparameters die de prestatie van echt Afrikaanse agrarische systemen en echt Afrikaanse huishoudens definiëren. Deze parameters worden gegroepeerd onder twee hoofdcategorieën, de agro-ecologische en de socio-economische. AGRA behandeld deze categorieën als losstaand van elkaar en heeft daarom geen enkele aandacht voor de relaties tussen het agro-ecologische (of hetgeen we *het milieu betreffende* zouden kunnen noemen, of 'natuur') en het socio-economische (of hetgeen wij 'cultuur' zouden kunnen noemen). Op zijn beurt leidt dit tot onoplettendheid t.a.v. de diversiteit van culturen en agro-ecologieën overal in Afrika, i.e. haar bioculturele diversiteit. Dit resulteert in allesomvattende aanbevelingen gebaseerd op over-gegeneraliseerde en over-gesimplificeerde aannames.

Bij het benadrukken van de noodzaak tot meer consideratie voor de relaties tussen cultuur en natuur – dat wil zeggen voor de diversiteit van Afrikaanse culturen, agro-ecologieën en socio-economische systemen en relaties, en voor de relaties tussen cultuur, agro-ecologie en sociale economie – stelt deze dissertatie drie verschillende sets van analytische parameters in wisselwerking voor. Deze parameters moeten worden overwogen indien de analyse inzichten in echt Afrikaanse landbouw en echt Afrikaanse boerenhuishoudens moet opleveren. Twee van deze sets van parameters komen voort uit een kritiek op AGRA's parameters, en een derde resulteert uit een oorspronkelijk ethnobiologisch raamwerk voor het bepalen van de aanvaardbaarheid van gewasvariëteiten.

Dit vergelijkend onderzoek , uitgevoerd tussen 2002 en 2008, betrof 206 boeren in twee dorpen in twee regio's van Zuid Kameroen. De methoden voor het verzamelen en analyseren van gegevens waren zowel kwantitatief als kwalitatief, en ontleend aan sociologie, anthropologie en ethnobiologie (cognitieve anthropologie). Kwalitatieve methoden voor het verzamelen van gegevens omvatten mede een bespreking van grijze en gepubliceerde literatuur, zomede ethnografische interviews en observatie van deelnemers. Kwantitatieve methoden omvatten vier enquêtes met gesloten vragen en cognitieve ethnobiologische stimuleringstechnieken (*freelisting* en *triade tests*). Kwalitatieve interviewgegevens werden gecodeerd en verhalend geänalyseerd met gebruik van Microsoft Word (beschrijving, verklaring, interpretatie, citaten). De gebruikte steekproef van huishoudens was niet groot genoeg voor toepassing van verfijnde statistische analyses die gebruik maken van een verdere onderverdeling van huishoudens. Dit beperkte de analyse van de interview gegevens tot hetgeen kon worden gedaan met gebruik van beschrijvende statistieken, zoals proporties, percentages en frequenties. Regressie-analyse werd spaarzaam toegepast. Culturele consensus analyse, nabijheidsanalyse, multidimensionale *scaling*, kwadratisch bepalingsproduct, cluster analyse, en *property fitting regression* werden gebruikt om de verzamelde ethnobiologische gegevens te analyseren.

De algemene conclusies van deze dissertatie bevestigen dat traditionele Afrikaanse polycultuursystemen en hun genetische diversiteit (gewassoorten en variëteiten) vaak in de milieucontext duurzaam zijn, en kunnen voldoen aan inkomens- en voedselbehoeften van landelijke huishoudens en gemeenschappen. Tevens kunnen zij meervoudige culturele behoeften bevredigen met betrekking tot identiteit, voedingsgewoonten, spiritualiteit, en sociale wederkerigheid. De aannames achter het bevorderen van AGRA-type technologieën zijn reductionistisch; ze houden geen rekening met de complexiteiten van Afrikaanse landbouw en inkomens, noch met de interrelatie tussen de sociale en culturele normen van boeren, hun toegang tot hulpmiddelen, hun inkomensstrategieën, en de wijze waarop zij landbouw beöefenen (b.v. configuraties in ruimte en tijd, aanplantpatronen, gewas- en variëteitskeuzes, culturele gebruiken). In het grootste deel van Afrika zijn kleine boeren en hun agroecosystemen stevig ingebed in ethnische en stamgemeenschappen, en houden zij zich meer of minder sterk aan culturele normen, geloof en sociale betrekkingen gebaseerd op verwantschap of afkomst. Hun landbouwkennis en -praktijken zijn vaak grotendeels gebaseerd op locale kennis en hulpbronnen. Zulke ‘traditionele’ landbouwsystemen vertegenwoordigen in het algemeen een langdurige aanpassing tussen cultuur en natuur, waarbij in de loop der tijd beide tesamen zijn geëvolueerd. De kennis en praktijken van boeren zijn ingebed in sociale betrekkingen waarbij vele bestaanswijzen worden gekenmerkt door betrekkelijk egalitaire verhoudingen ter verzekering dat hulpbronnen zodanig worden verdeeld dat ieder voldoende middelen heeft om aan zowel sociaal gedefiniëerde als biologische behoeften te voldoen. Niet-duurzame praktijken en niet-egalitaire sociale betrekkingen die gepaard kunnen gaan met het overnemen van technologieën van de Groene Revolutie en sterkere marktintegratie, leiden doorgaans op de lange termijn niet tot aanpassng.

De aannames die aan de ‘New Green Revolution for Africa’ ten grondslag liggen vormen een drastische oversimplificatie van traditionele Afrikaanse landbouwsystemen en negeren hun diversiteit. Aldus gaan ze niet overal in Afrika op, en dit kan nog een andere bedreiging bieden voor de integriteit van traditionele Afrikaanse cultures, agro-ecologische systemen, en biologische diversiteit. Acht belangrijke punten van kritiek op deze oversimplificatie en de gevaarlijke consequenties daarvan voor Afrikaanse boerenhuishoudens zijn: i) in de meeste Afrikaanse contexten zijn de aanbevelingen voor geïntegreerde praktijken van bodemvruchtbaarheids beheer en kunstmestgebruik niet toepasbaar (door technische en praktische beperkingen); (ii) er is een gebrek aan consideratie voor de sociale beperkingen van boerenhuishoudens: uiteenlopende toegang tot inkomen, land en arbeid, en tot investeringen in andere activiteiten ten behoeve van levensonderhoud die concurreren met investeringen in de inbreng voor de landbouw die bijgevolg implicaties kunnen hebben voor bodemvruchtbaarheids beheer; (iii) er is een gebrek aan aandacht voor die plagen en ziekten die voor de boeren het meest relevant zijn; (iv) er is een betrekkelijk gebrek aan aandacht voor de behoefte aan het ontwikkelen van variëteiten conform de lokale voedingsgewoonten, voedselbewerking en opslagsituatie; (v) er is weinig aandacht voor de gevolgen van massaproductie en de beperking van de diversiteit van gewassen en variëteiten op voedselzekerheid en voeding en op de menselijke gezondheid; (vi) er is verder een gebrek aan serieuze aandacht voor boerenkennis en -praktijken op het gebied van gewasvermeerderingsstrategieënen en het gebrek aan precieze methodologieën teneinde effectief en systematisch de boerenkennis van variëteiten, hun inzichten en –voorkeuren, en het relateren daarvan aan het al dan niet accepteren van bepaalde rassen te inventariseren en te documenteren; (vii) de aanname dat prijzen voor massaal geproduceerde HYV’s het inkomen en de investering in gewashulpmiddelen zullen verhogen is onwaarschijnlijk; en (viii) aanbevelingen van het AGRA type hebben een omschakeling tot monocultuur tot gevolg met grote consequenties voor het levensonderhoud en voedselzekerheid.

Gebaseerd op deze punten van kritiek, is de belangrijkste beleidsaanbeveling die in deze dissertatie wordt benadrukt, meer consideratie te geven aan echt Afrikaanse landbouwsystemen en echt Afrikaanse boeren, en aan het hoe en waarom van hun functioneren dat – zo wordt betoogd - moet dienen als vertrekpunt voor landbouwbeleid en programma’s overal in de regio, indien deze erin moeten slagen zulke boeren, hun gemeenschappen en naties te steunen. De cultuur van de boeren, hun sociale betrekkingen, kennis, praktijken en ervaringen - zowel in de ‘Nieuwe’ als in de ‘Oude’ Groene Revolutie een zogenaamde zwarte doos - zouden opnieuw in beschouwing genomen moeten worden in beleid en in onderzoek en ontwikkeling als zijnde positieve vertrekpunten voor het verhogen van de voedselzekerheid in Afrika.

Curriculum Vitae

Ntumngia Regina Nchang was born in Bafut – Mezam, North West Province - Cameroon, on 21st April 1961. She pursued her primary, secondary and high school education in both Presbyterian Mission and Government institutions in Cameroon from 1966 to 1980. In 1984, she graduated with distinction as an Ingenieur des Travaux d'Agriculture (Agricultural Works Engineer) with specialisation in Animal Production from the Dschang University, Cameroon. In 1995, she obtained a Diploma in "Maternal and Child Nutrition: the Prevention of the Majour Nutritional Disorders in the World" at the International Agricultural Centre (IAC), Wageningen, the Netherlands. She obtained her M.Sc degree with a distinction in "Management of Agricultural Knowledge Systems" with specialisation in Extension Science, Education and Gender Studies in 1997 from the Wageningen University. In 1998, she was awarded a Sandwich Fellowship by Wageningen University to undertake her PhD studies, which she effectively started in 1999 in the Department of Social Sciences. She returned to complete her PhD in 2006 with a African Women Leaders in Agriculture fellowship program of Wageningen University and Winrock International in 2006. She carried out intensive research work in Koudandeng – Obala and Malende – Muyuka, Cameroon. She was also a visiting PhD researcher at the University of Kent in the UK.

She has twenty five years of working experience and has held various posts of responsibility in the Ministries of Agriculture and Rural Development and Scientific Research and Innovation, Cameroon: Chief of Service in Charge of Relations with Agricultural Research; Assistant Unit Head in Charge of Extension Norms and Methods; Inter-Provincial Controller of National FAO/WFP projects for the Littoral and South West Provinces; Provincial Coordinator FAO/WFP projects for the North West Province; and Research Assistant/Technical Staff in Charge of the Milk Programme, IRZ – Wakwa, Ngoundere.

Regina Nchang has acquired strong inter-disciplinary foundations in anthropology, ethnobiology, sociology, gender studies, agroecology, and agricultural extension science and education. She has working experience in rural development policies and practice in Africa and has worked as a researcher, an agronomist, extensionist, and gender expert. She is accustomed to multi-tasking and coordinating resources effectively to meet targets within stringent project deadlines. She has strong participatory action research and quantitative and qualitative skills and has acquired experience in agroecological farming and food system analysis, analysis of plant genetic resources for food and agriculture and agricultural research institutions and programmes; structuring and organisation of the rural milieu; quantitative and qualitative network analysis of agricultural knowledge and information systems; training and supervision; and publication and report writing.

She has produced a number of publications and congress papers including: i) Uncovering Farmers' Ethnobiological Knowledge: A Methodology for Assessing Farmers' Perceptions of Cassava Varieties (poster, 12th International Conference of Ethnobiologists, Tofino – Canada; In Proceedings, 9th African Crop Science Conference, *Journal of African crop science Society*, 2009); ii) The Missing Link: Male and Female Farmers' Decision Making Frameworks in Cassava Genetic Diversity Management (In Proceedings, 8th African Crop Science Society, *Journal of African Crop Science* 2007); iii) Uncovering Local

Understanding of Cassava Varietal Selection, Obala-Cameroon. *Gene Conserve pro br artigos indice*, 2006); iv) Gender Power Dynamics and Knowledge Systems in Household Food Security: A Case Study of Malende and Mautu Cassava Farmers. Muyuka – Cameroon, 1997. MSc; and v) The Impact of the Importation of Exotic Cattle Breeds on Milk Production in Cameroon: The Case of the Introduction of Holstein Freisian and Jersey Cattle Breeds, 1984. 1st Degree.

Regina Nchang has received numerous national and international fellowships and awards, including: i) LEB Foundation, Wageningen University, The Netherlands, 2010; ii) CTA/RUFORUM Grant, 2009; iii) African Crop Science Society (ACSS) Grant, 2007; iv) CGIAR Gender and Diversity Award, 2006; v) the Brazilian Government Award, 2006; vi) PhD fellowship award from the African Women in Agriculture and the Environment (AWLAE) of Wageningen University and Winrock funded by the Netherlands' Ministry of Foreign Affairs, 2006; vii) Norman Borlaug Fellowship Program for West African Women Award, 2005; DSE – Federal Government of Germany Award, 2000 & 2003; viii) PhD Sandwich Construction from the Wageningen University since 1998; ix) Winrock International and the African Women in Agriculture and the Environment (AWLAE) Fellowship Award through the Ecologically Sustainable Cassava Plant Protection Project (ESCAPP) - Cameroon, 1995 to 1997; x) the Netherlands Government Student Award, 1995; and xi) the Cameroon Government Student Award, 1981 – 1984.

Regina Nchang is a member of the African Crop Science Society and the International Society for Ethnobiology. She is affiliated with the Working Group on Girls International – Cameroon; Family Movement Common Initiative Group- Cameroon, Mother is Gold International – Cameroon, and Caring Sisters Common Initiative Group – Cameroon. She is a mother of four children.

AWLAE
African Women Leaders in Agriculture and the Environment

The present thesis is one of a series. It represents the fruits of a collaboration between African Women Leaders in Agriculture and the Environment (AWLAE), Winrock International (WI), and Wageningen University and Research Centre (WUR). AWLAE is a pan-African program that aims at training women professionals in the fields of agriculture and environment, to redress the existing gap between male and female representation in professions relating to these fields. AWLAE was initiated by Winrock International in 1989. Its headquarters are in Nairobi, Kenya.

Between AWLAE, WI, and WUR a project was formulated that was submitted for funding to the Minister for Development Cooperation of the Netherlands Ministry of Foreign Affairs. The goal of the project was to build a cadre of well-trained African women professionals working in agriculture, environment and related sectors to enhance their academic standing and capacity to contribute to gender-relevant research and policy-making on the role of women in food systems and the gendered impacts of HIV/AIDS on food security and rural livelihoods in sub-Saharan Africa. In April 2002 the project was granted. The Ministry agreed to fund twenty PhD scholarships at Wageningen University and the additional leadership-in-change training for twenty women from eleven African countries, ranging from East to West and Southern Africa. In June 2002 an agreement was signed between AWLAE, represented by its Regional Director, and the Director of the WUR Social Sciences Group, after which implementation of the project could start. The participating scholars were carefully selected from a large number of applications. The scholarships were widely advertised in relevant media in countries with AWLAE chapters, and the chapters concerned were actively involved in the recruitment and selection of the candidates.

The following women participate(d) in the AWLAE scholarship project:

Susana Akrofi (Ghana)
Hirut Bekele (Ethiopia)
Namizata Binaté Fofana (Ivory Coast)
Joyce Challe (Tanzania)
Fatimata Dia Sow (Senegal)
Stephanie Duku (Ghana)
Rose Fagbemissi (Benin)
Kidist Gebreselassi (Ethiopia)
Monica Karuhanga (Uganda)
Doris Kakuru (Uganda)
Mariame Maiga (Ivory Coast)
Lydia Ndirangu (Kenya)
Aifa Fatimata Ndoye Niane (Senegal)
Faith Nguthi (Kenya)
Carolyne Nombo (Tanzania)
Regina Ntumngia Nchang (Cameroon)
Daisy Onyige (Nigeria)
Gaynor Paradza (Zimbabwe)
Corrie du Preez (South Africa)
Ekaete Udong (Nigeria)

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