POTENTIAL ADOPTION OF GRAIN AMARANTH PRODUCTION IN HIV/AIDS-AFFECTED RURAL KENYAN COMMUNITIES

By

THOMAS BROOKE GILL

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To my wife, Betsy and our beautiful daughter, Melissa

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

CRWRC	Christian Reformed World Relief Committee
Chapatti	Flat bread similar to a tortilla made from wheat flour
ELP	Ethnographic Linear Programming
FHH	Female-headed household(s)
Jembe	Traditional hoe used for land preparation and weeding
Jerry Can	Plastic container used to collect and store water
MHH	Male-headed household(s)
Mandazi	Fried snack similar to a donut
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal
Shamba	Kiswahili term for “field” or “farm”
Ugali	Traditional bread made from boiling maize, cassava, sorghum , millet and/or amaranth flour

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Thomas Brooke Gill

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This study investigated the potential for the adoption of grain amaranth production as a livelihood strategy among households in two HIV/AIDS-affected communities – Amukura, Teso District, and Mwatate, Taita-Taveta District, Kenya. Livelihood system and ethnographic data were collected in the field from semi-structured household interviews and focus groups. Twelve male-headed households and four female-headed households with dynamic compositions and representative of the diversity of households in Amukura and Mwatate were selected using referral sampling. Data were analyzed for factors influencing the acceptance of grain amaranth and then used to construct three ethnographic linear programming models for each community to simulate diverse households' decisions in the current livelihood systems, with the introduction of grain amaranth as a potential livelihood strategy, and following the impact of an adult member contracting HIV. Findings revealed that acceptance of grain amaranth was most affected by socio-cultural factors. These included prior knowledge of amaranth, the methods of communication about grain amaranth, the source of grain amaranth information, and cultural concepts of grain amaranth including community myths and the traditional role of amaranth in a proper Kenyan meal. Initial ELP analysis

revealed that households were more apt to adopt grain amaranth if they were not consuming enough protein, struggling to meet cash and consumption requirements, or lacking in adult female labor while adult male labor was still plentiful. In addition to these factors HIV analysis indicated that households were more apt to adopt grain amaranth if they were male-headed, had a high consumer-producer ratio, low land availability and sufficient available cash. Grain amaranth was also more likely to be adopted by a household when an adult female contracts HIV than when an adult male contracts HIV. Grain amaranth production has significant potential for adoption but varies in accordance with the diverse capacities and responses of rural households. Efforts to increase acceptance and adoption of grain amaranth can be enhanced by adopting a holistic approach which appreciates this diversity within the complexity of rural livelihood systems.

CHAPTER 1
INTRODUCTION

In the year 2000, the United Nations (UN) established eight Millennium Development Goals (MDGs) to achieve around the world by 2015. Current UN reports highlight that sub-Saharan Africa is not on target to meet any of these goals, and in some cases the situations have deteriorated since 2000 (United Nations, 2007). However, the UN maintains that these goals are still achievable in sub-Saharan Africa, and that there is an urgent need for practical action. This study focuses on issues outlined in two of these development goals, in particular the first goal which aims to eradicate extreme poverty and hunger, and the sixth goal which aims to combat HIV/AIDS, malaria and other diseases. Extreme poverty, hunger and HIV/AIDS are all serious issues facing Kenya today.

The total population of Kenya more than doubled between 1979 and 2003 (CBS, 2006; United Nations Population Division, 2003), and this increase has led to a 50% increase in population density in rural agricultural areas (FAO, 2006). This increase in rural population density has led to increasing fragmentation of land holdings and decreasing food security in many rural areas. Thus, the majority of the people in these areas are not farming large holdings, and these people can therefore be considered smallholders. Furthermore, the number of people suffering from malnutrition in Kenya is continuing to increase, as the total available calories per capita per day have fallen from 2,211 in 1970 to 1,965 by 2000 (Gitu, 2006). It is thus probable that extreme hunger is a serious problem in many of these densely populated rural areas. In addition, extreme poverty is rampant throughout Kenya. It is currently estimated that 58% of the Kenyan population live on less than $2 per day (UNAIDS, 2007a). In order to tackle both this

extreme hunger and extreme poverty, attention must be paid to the agricultural sector, which involves between 80 and 90% of the Kenyan population. This sector also continues to supply almost 25% of Kenya's GDP (Gitu, 2006), making it of primary developmental policy concern.

The majority of rural, limited-resource households are also affected both directly and indirectly by HIV/AIDS. It is currently estimated there are between 1.5 and 2 million Kenyans living with HIV, representing between 4.0 and 5.3% of the total population (UNAIDS, 2007b). This is comparable to the average prevalence rate of 5.0% for sub-Saharan Africa as a whole (UNAIDS, 2007b). There is therefore an urgent need to identify livelihood strategy[1] options that can benefit households affected by HIV/AIDS. The need for research focused on these rural, smallholder livelihood systems[2] is therefore crucial for the identification of strategies to help achieve the MDGs.

Development efforts to help these rural poor have too often overlooked the great diversity in rural livelihood systems and communities. Instead, these efforts have typically used top-down strategies, offering broad-based solutions, ignoring indigenous knowledge and resulting in little success. This has led to the rise of participatory methodologies as alternative ways to approach development, spearheaded by figures such as Robert Chambers. Chambers (2005: 157-158) notes that farmers in rural, resource-limited livelihood systems have goals which do not conform to Western prerogatives of simplifying, standardizing, controlling, and substituting capital for labor:

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[1] A livelihood strategy is one of the possible activities that a household could engage in within the framework of a livelihood system. Livelihood strategies undertaken are both household and time specific (Hildebrand *et al.*, 2006).

[2] A livelihood system is defined as the numerous bio-physical and socio-economic forces and factors that affect the family (Pomeroy *et al.*, 2002). It encompasses all possible activities reasonably available to households to engage in.

> "…[they] often seek to reduce risk and increase food and income by complicating and diversifying in their farming systems, intensifying labour use, adding to their enterprises, and maximizing management."

These rural livelihood systems are based around a network of family farms that are first and foremost homes, not businesses (Hildebrand *et al*., 2006). Attention to the complexities of these rural livelihood systems is thus critical if development efforts are to succeed. Farm heterogeneity and its driving factors, such as the gender division of labor, seasonality in labor supply, demand, and system production, and dependable yields (rather than average yields) need to be assessed with careful consideration (Tittonell *et al.*, 2007).

This study adopts a holistic livelihood systems approach to assess the potential adoption of an agricultural intervention into two communities in Kenya. The overall goal of this study is to examine whether grain amaranth is a livelihood strategy option that could reasonably be expected to be adopted by diverse rural households that are constrained by poverty, malnutrition, and HIV/AIDS.

Impacts of Recent Civil Unrest

The violence following the disputed December 2007 elections resulted in widespread insecurity and significant disruption of livelihood systems across Kenya. Food insecurity in particular became more widespread as a result of the destabilized political environment. Although the provinces of Western and Coastal Kenya, in which the research for this study was conducted, did not witness the worst of the violence, the unrest caused many problems. These included the instability of local and regional markets, including a rapid increase in the price of basic commodities, such as food products and fuel, as well as transport disruption and reduced market access for many people. Furthermore, food insecurity increased as a result of the increasing insecurity of

land tenure in many areas, as conflicts which had been simmering since the colonial period emerged seeking to redress inequities of land distribution (Klopp & Kamungi, 2008).

The post-election violence not only increased food insecurity, but also seriously affected care-giving for people living with HIV/AIDS. Immediately following the post-election violence, there was a disruption in public health services in Nairobi (Obonyo, Omondi & Mwinzi, 2008), and HIV/AIDS care-giving and treatment services in particular were affected (Reid *et al.*, 2008). It is very likely that the violence also led to increasing difficulties to supply treatment and provide care for people living with HIV/AIDS in rural areas, as these areas are difficult to reach and often depend on Nairobi and other cities for their supply of antiretroviral drugs and coordination of care-giving services.

Christian Reformed World Relief Committee and its Grain Amaranth Promotion Program

Christian Reformed World Relief Committee (CRWRC) is a non-profit organization working around the world in many issues of relief and development. CRWRC works with a total of seven indigenous partner organizations in Kenya that are working in 52 different communities across the country (CRWRC, 2006a). CRWRC has worked with partner organizations in Kenya since 1999 with the promotion of two species of grain amaranth (*Amaranthus cruentus* and *Amaranthus hypochondriacus*). The partner organizations that are promoting grain amaranth in the field sites where this research was conducted are the Western Region Christian Community Services for the Anglican Church of Kenya (WRCCS-ACK) in Amukura, Western Province, and the Pwani Christian Community Service (PCCS) in Mwatate, Coastal Province. These organizations are introducing grain amaranth primarily as a food crop to increase food

and nutrition security in rural, limited-resource households[3]. Grain amaranth, an under-utilized pseudo-cereal, is being promoted as an additional livelihood strategy option, not as an alternative for other staple crops, for rural, limited-resource households. In particular, grain amaranth is being promoted as a possible strategy for improving the nutrition of households affected by HIV/AIDS. CRWRC and its partner organizations are emphasizing the nutritional qualities of grain amaranth that make it a viable option for households to consider in its potential to enhance the immune systems of people living with HIV. Therefore, the inclusion of grain amaranth as an additional livelihood strategy option to improve nutrition of HIV/AIDS-affected households may well be a way for these households to break the debilitating cycle of HIV/AIDS and food and nutrition insecurity.

Researchable Problem

Currently, it is not known whether grain amaranth is a feasible livelihood strategy option for diverse limited-resource households in rural Kenyan communities. The adoption of grain amaranth as an additional livelihood strategy requires greater investments in land, labor and cash that these households may not be able to afford. It is not known therefore whether households who adopt grain amaranth would adopt it as an additional livelihood strategy option or an alternative option to other strategies. It is also not known whether grain amaranth can actually increase the food security of households that adopt its production as a livelihood strategy.

Although it is widely postulated that HIV/AIDS has severe negative impacts upon household food security, few empirical studies have been conducted that seek to both

[3] A rural, limited-resource household has been defined as “one whose resources of land, water, labour and capital do not currently permit a decent and secure livelihood” (Chambers & Ghildyal, 1985).

quantify this impact and determine which types of household are less able to cope with the shock of a household member contracting HIV. Furthermore, it is not known whether or not the impact of HIV infection enhances the likelihood of a household to adopt grain amaranth as a livelihood strategy. It is therefore important to examine whether grain amaranth has the potential to increase household food security in the face of shocks to the household such as HIV infection of household members.

The success of extending an innovation such as grain amaranth production to rural communities depends primarily on a significant number of households adopting the innovation. However, rural households are diverse in terms of available resources and composition. It is therefore important to identify which types of household are most likely to adopt grain amaranth as a livelihood strategy option, as this information will be crucial in enhancing the effectiveness of ongoing and future grain amaranth promotion efforts across East Africa.

Purpose of the Study

This study seeks to understand why rural households do the things they do, and looks at patterns of potential adoption of an innovation by diverse households. Specifically, this research will focus on the introduction of grain amaranth into rural Kenyan communities. Although there is a range of nutritional benefits from grain amaranth consumption (Bressani, 1988; Meitzner & Price, 1996), and although high levels of grain amaranth production are possible in East Africa (CRWRC, 2006b), there is no current research on whether grain amaranth production is a viable additional livelihood strategy for rural, limited-resource East African farmers to adopt as one of their livelihood strategies. Thus, there is a need to bridge the gap between biological knowledge concerning grain amaranth and knowledge of Kenyan rural livelihood

systems to examine how amaranth might fit into rural smallholder livelihood systems for diverse kinds of limited-resource households. The main objectives of this study were therefore first to examine the potential for adoption of grain amaranth by limited-resource households in rural Kenyan communities within the context of their existing livelihood systems, and secondly to examine the impact of HIV infection of adult household members upon the potential adoption of grain amaranth by these same households.

In this context, there is a need to understand the appropriateness of the introduction of grain amaranth, and to identify types of households in these systems for which grain amaranth production may be a viable livelihood strategy. By tackling such issues, the gap between the knowledge and practices of CRWRC and its partner organizations in the promotion of grain amaranth and the knowledge and practices of rural, limited-resource households can be narrowed.

Research Questions

To address the researchable problem and to effectively meet the overall purpose of this study, four research questions are tackled in the following chapters:

1. What are the current livelihood systems of the two communities (Amukura and Mwatate) and the current livelihood strategies adopted by diverse households within these communities?

The objective of this research question is to identify and describe the livelihood systems of the two communities through identifying and describing the diverse livelihood strategies undertaken by rural, limited-resource households with diverse household compositions.

2. What are the social attitudes towards grain amaranth in Amukura and Mwatate?

The objective of this research question is to assess both positive and negative attitudes towards production and/or consumption of grain amaranth by diverse households within each community.

3. For which kinds of household is grain amaranth production a feasible livelihood strategy option in these communities?

The objective of this research question is to identify the kinds of household that have the greatest potential for grain amaranth adoption as a livelihood strategy. Multiple factors generating differential responses to grain amaranth between diverse households are analyzed, including household composition, worker-consumer ratio, land and seasonal labor and cash availability.

4. What is the impact of HIV/AIDS upon the potential adoption of grain amaranth as a livelihood strategy by diverse households in these communities?

The objective of this research question is to identify the impact of HIV infection upon the potential adoption of grain amaranth between households within each community and between the two communities as a whole. Underpinning this objective is the aim of identifying whether households are more likely to adopt grain amaranth if an adult member contracts HIV, and what is the difference in potential adoption of grain amaranth between an adult male and an adult female household member contracting HIV.

Significance of the Study

This significance of this study rests on three attributes. First, this study crucially focuses on roles and livelihoods of smallholder farmers who are the backbone to Kenya's food security. This study underlines the importance of holistic research, development and extension approaches by considering the entire livelihood systems of rural communities composed predominantly of smallholders. By understanding the

complexity of these systems and the diversity with which rural smallholders operate, potential adoption of an innovation such as grain amaranth can be examined effectively.

Secondly, this study highlights the importance of a methodology that can be an effective tool in examining the potential adoption of any innovation by a community. This study demonstrates the versatility of the methodology by extending it to assess the impact of HIV infection, a typical scenario in these communities, upon livelihood strategy decisions and in particular potential grain amaranth adoption.

Finally, this study addresses important questions facing organizations working on the frontlines to increase the food security of rural households. This study provides important and crucial data to these organizations regarding not only potential adoption of grain amaranth, but also the livelihood systems and decision-making activities of diverse households within rural communities. It is hoped that this information will enable these organizations to be even more effective in their work with these communities. This study therefore is extremely significant as it moves beyond purely academic research, having real impacts upon the lives of the poor and the hungry in Kenya today.

Organization of the Study

This study begins with the general introduction presented here in Chapter 1. In Chapter 2, a literature review of relevant issues is presented. The review covers the history of agricultural research and extension in Kenya's development, a discussion of the household level (the level of analysis of this study) and gender issues, and a background to amaranth, agricultural marketing in Kenya, and HIV/AIDS and its history in Kenya.

The methods used in conducting this research are presented in Chapter 3. This includes an outline of the two study areas, followed by a discussion of the sampling

technique employed, and a description of the data collection process. Data were collected using two primary approaches: individual interviews following a Sondeo (an informal, conversational-style semi-structured interviewing methodology) framework, and focus group interviews and activities based around participatory tools. This chapter concludes with a discussion of the method of using ethnographic linear programming (ELP) as a tool to describe and understand a livelihood system and as a framework for analyzing household livelihood decision-making processes.

Chapter 4 addresses the first research question of this study. The livelihood systems of Amukura and Mwatate are presented and analyzed. The livelihood strategy decisions of diverse households in both communities are assessed using an ELP model (entitled BASIC) for each system. The differences between these systems and among the diverse households are discussed.

Before any assessment of the potential adoption of grain amaranth can be made, it is instructive to analyze the factors influencing acceptance of grain amaranth into both Amukura and Mwatate. Chapter 5 thus deals with the second research question, through a discussion of a model of food acceptance. This discussion highlights the most important factors influencing the acceptance of grain amaranth as a food in each community, and assesses the differences in acceptance between the two communities.

Chapter 6 addresses the third research question, assessing the potential adoption of grain amaranth by diverse households within each community. This chapter presents the AMAR ELP models for each system, which are an extension of the BASIC models to simulate the introduction of grain amaranth as a livelihood strategy in the communities. The results of the AMAR models' simulations are analyzed to assess

differences in livelihood strategies undertaken: among diverse households; between households in Amukura and those in Mwatate; and compared with the results from Chapter 4's BASIC model simulations.

The fourth and final research question, assessing the impact of HIV infection of an adult household member upon the potential adoption of grain amaranth is addressed in Chapter 7. Two ELP models for each livelihood system are used to assess these impacts – one model to simulate the impact of HIV infection of an adult male in a household (HIV+ M model) and another to simulate the impact of HIV infection of an adult female in a household (HIV+ F model). The results of these model simulations are analyzed to assess differences in livelihood strategies undertaken: among diverse households in each community; between households in Amukura and those in Mwatate; when compared with the results from chapters 4 and 6; and the differences between the two HIV models themselves.

Chapter 8 is the final chapter of this study, providing conclusions and recommendations, future research possibilities and policy implications. This chapter seeks to highlight the major lessons learned from this study, and what action needs to be taken as a result.

CHAPTER 2
LITERATURE REVIEW

History of Agricultural Research and Extension in Kenya's Development

Kenya Pre-Independence

Kenya, under colonial rule since the end of the 19th century, gained independence from the United Kingdom in 1963. Although the British officially pulled out, they left Kenya with a colonial legacy that continues to influence government and policy even today. Before the colonial period, the various ethnic groups in Kenya were (compared to today) low in population, and were strongly tied to cultural traditions and to the land. This rapidly changed, however, with the implementation of colonial rule and policy, in which the British imposed laws to facilitate massive land seizures for white settlers. Africans were given the choice to either live in native reserves or become squatter laborers on what then became European-owned farms (Rodgers, 1991). Overcrowding, increasing person-land ratios, and growing social problems on the reserves led to an increasing number of violent confrontations between the Africans and the European settlers. Eventually, on October 20, 1952, the British declared a state of emergency, in response to the Mau Mau Rebellion (Rodgers, 1991).

One of the main ways in which the colonial government reacted to the Mau Mau was through the imposition of a rational Weberian model of land reform, based upon adjudication and subdivision (Juma & Ojwang, 1996). The colonial government imported a model based on the economic efficiency paradigm and a Western and capitalist understanding of private property rights. This model was put into practice through the Swynnerton Plan of 1954, which had the fourfold aim of quelling political dissent, increasing agricultural productivity through increasing efficiency of farm production, the

development of a land market, and increasing the production of cash crops (Place & Migot-Adholla, 1998). The Swynnerton Plan proposed that individual ownership of land was the most rational, efficient and productive way of managing land, rather than the assumed “native” communal ownership of land. Thus, a large project of land tenure reform was begun in central Kenya, which gradually was enforced throughout the country (Haugerud, 1989). This project entailed first the process of ascertaining family use rights to portions of land, which were recorded in the name of the family head (adjudication), followed by consolidation of these fragmented portions into a single unit of land, for which a title was then registered (Musyoka, 2006). However, this process of land reform only served to decrease land tenure security for the majority, especially for women who lacked access to attaining land titles. There was also the rapid growth of a landless class, which was faced with few prospects in terms of employment. Furthermore, the focus on cash crops failed to understand the need to first focus on providing food for the rapidly expanding Kenyan population as well as for those farmers who were producing the cash crop commodities (KHRC, 1998).

Kenya Post-Independence

When independence was finally granted in 1963, the new government adopted, maintained and reinforced colonial strategies of governance and administration. The strategies of land privatization and registration embarked upon under the Swynnerton Plan were continued, enabling political and bureaucratic elites alike to take advantage and obtain large portions of the white highlands for themselves (KHRC, 1998; Williams, 1996). Meanwhile, the government maintained the colonial British style of field administration which was organized in terms of ministries, of which the Ministry of

Agriculture was responsible for formal agricultural research and extension efforts in Kenya.

Agricultural Research and Extension in Kenya

Agricultural research and extension are tools that are used to tackle the issue of rural development and improve the lot of farmers. The introduction of innovations[1] through extension to farmers is an important part of this development effort. The term extension was first used in the 19th century in England to describe adult education programs. Since the turn of the 20th century, the term has been widely adopted in the agricultural sector, in which agricultural extension was traditionally viewed as a uni-directional process, involving the transfer of new technologies and information from a research center to the farmers (Leewis, 2004). This view of extension as a persuasive and top-down strategy emerged in colonial times and following the dismantling of colonialism many developing countries, including Kenya, maintained the pre-existing agricultural extension service structures (Anderson, Feder & Ganguly, 2006).

In the 1960s, there was an altogether positivist development climate, in which it was strongly believed that all that was needed was for Third World countries to "catch up" with the rest. Focus upon technology transfer and diffusion from the First World to the Third World was paramount, and the effects of this focus were transferred directly to agricultural extension efforts in developing countries. Agricultural extension efforts in many countries, including Kenya, typically followed the conventional Transfer of Technology (ToT) approach promoted by the World Bank, and were primarily state-led. The ToT approach was based on the generation of new ideas and technologies at a

[1] An innovation can be here defined as "anything new that is successfully introduced into an economic or social process" (Davis *et al.*, 2007).

centralized research station, from which these innovations were disseminated by the state-led extension service to farmers. Kenya followed an export-led agricultural growth strategy; therefore many technologies that were developed and disseminated were for export crops. Along with this, there was the development of high-yielding varieties of staple cereals coinciding with higher output prices due to food scarcity in many developing countries, and so it was thought that dissemination efforts would be warmly received by grateful farmers (Anderson *et al*., 2006).

However, it soon became clear that the positivist approach of the 1960s had failed to reach the majority of the poor. In attempts to redress this problem, the 1970s witnessed the rise of “basic needs” approaches. Donor organizations turned their attention to rural development and programs targeting the satisfaction of basic needs, reduction of poverty, and the reversal of inequalities between poor and rich. This led to an increasing interest in rural farming systems, and farming systems approaches began to emerge with a focus on thinking of systems in holistic terms. However, these approaches continued to be technically focused and managed vertically, with a failure to emphasize training and linkages between management and research, and a frequent inability to build capacity of rural smallholders. As a result, in many cases, the poor were still marginalized and the gap between rich and poor continued to widen.

Meanwhile, the World Bank had not given up on broad-scale “solutions” to problems of rural poverty, and sought to improve the effectiveness of the ToT approach by encouraging countries to adopt its proposed extension organization model of Training & Visit (T&V) extension (Benor, Harrison & Baxter, 1984; Benor & Harrison, 1977). Developing countries’ extension services were viewed as inefficient and

ineffective and by adopting the T&V model, it was hoped that the performance of extension services could be enhanced. This organizational model of extension was adopted by the Kenyan agricultural extension service in 1981 (Bagchee, 1994). The T&V model was a blueprint approach with core principles fixed upon hierarchy, rigid scheduling of training and visits, and a concentration on major staple crops (Anderson *et al.*, 2006).

Technology diffusion by the extension services under these World Bank approaches closely resembled Rogers' (1983) model of diffusion of innovations, which focused on a very linear process of technology development. This linear process was a very easy model to follow and implement, hence it became very popular with development and extension workers. In his theory, Rogers attempted to explain how individuals in communities respond to the introduction of innovations. His theory proposed that technologies are communicated over time among the members of a social system, and adopted according to various characteristics of both the technology and the user. Rogers argued that differences in an individual's evaluation of various aspects of a technology lead to differences in their decisions of timing to adopt. Based on the timing of one's decision to adopt an innovation, therefore, he proposed that people could be split into five different "adopter categories," ranging from innovators (earliest to adopt) to laggards (latest to adopt).

The implementation of the T&V model coincided with the implementation of Structural Adjustment Programs (SAPs) in many developing countries (Bryceson, 2002; Lele, 1990), including Kenya, by the World Bank and the International Monetary Fund (IMF). In the early 1980s, Kenya was in a deepening economic crisis involving

increasing foreign debt brought about by a combination of factors including the rapid increase in oil prices and prolonged drought. With the market being advocated by these international financial organizations as the best way to reallocate resources and improve the economy, SAPs were implemented to liberalize markets. SAPs were simultaneously implemented to reduce the size of government, increasingly seen as inefficient, bureaucratic and corrupt, and subsequently Kenya's civil service was drastically cut. Meanwhile, privatization of government services was strongly encouraged for greater efficiency and effectiveness.

However, it soon became clear the growth in the private sector was not keeping pace with the reduction in the public sector. This has led to a deepening economic crisis in Kenya that has affected not only urban but also rural areas. The T&V system of extension could no longer be financially supported nor were there sufficient staff necessary to enact it. The cost of inputs, such as seed and chemical fertilizer, rapidly increased and rural, resource-limited farmers were further marginalized. Furthermore, the approaches based on ToT, T&V and Rogers' diffusion model began to be discredited, even by those who first promoted them (Anderson *et al.*, 2006; Gautam, 2000). Although the delivery system of T&V was an improvement in effectiveness of the extension service in Kenya, the system was top-down and supply-driven, and many innovations and messages that were assumed to be relevant and useful and were disseminated turned out to be irrelevant to farmers' needs (Chambers & Ghildyal, 1985; Gautam, 2000). In such cases, therefore, the notion of "adopter categories" has been shown to be redundant (Leewis, 2004). This extension approach left little room for farmer feedback, the role of indigenous technical knowledge (ITK), and gender issues.

The rigidity of the structure of the ToT approach in a T&V organizational model also ironically reduced the possibilities for innovation.

Moving Beyond the State: Agricultural Extension Pluralism at the Turn of the 21st Century

Realizing the limits of state-led extension and the decline of the T&V approach, donor organizations funding agricultural research and extension have increasingly proposed the need for agricultural extension pluralism. Over the past 15 years, this pluralism has emerged in Kenya and many other countries, with the current existence of a wide range and variety of extension approaches (Muyanga & Jayne, 2006). In Kenya, state-led approaches are now not the only method of agricultural extension. Of special note is the proliferation of non-governmental organizations (NGOs) that are now working in the field in extension.

Together with the increase in alternative extension approaches has come the re-emergence of farming systems approaches that are more closely tied to farmer needs, feedback, and assessments. It has been argued that the “problem” of slow or non-adoption of innovations by rural, resource-limited farmers can be better understood in the context of the whole farming system. Such farmers typically operate complex, diverse systems in order to minimize risk. These farmers have unique sets of problems that do not match those of larger farms, which were favored under the ToT approach. It has become increasingly clear that broad-scale approaches will not necessarily meet the needs of smallholder farmers (Davis, 2004, Monu, 1983).

Therefore, recognizing the need to understand the complexity and diversity of the livelihood systems in the proposed communities of study, this research is based on a

farming systems approach. At the core of this approach is agricultural systems[2] theory (Spedding, 1988). This theory states that an understanding of the whole system of which farmers are a part is necessary in extension and development efforts. There is an increasing emphasis on viewing the farm as a whole, as an interactive, dynamic system that is part of a larger interconnected system of multiple scales. This theory views farmers as active participants in their system, and recognizes the importance of farmer feedback, experimentation and knowledge.

There have been a number of models of agricultural research proposed as a way of moving beyond the conventional ToT approach and toward using a farming systems approach, including the farmer-back-to-farmer model (Rhoades & Booth, 1982) and the farmer-first-and-last model (Chambers & Ghildyal, 1985). These models highlight the importance of holistic and interdisciplinary appraisal of farm families' needs, resources, and constraints, with the emphasis on research driven by needs and from the farmer (i.e. bottom-up). Also, such approaches place emphasis on the need for increased participation of all stakeholders in research and extension efforts. Furthermore, there is an increasing need to consider previously neglected as well as contemporary issues facing rural livelihood systems, such as the importance of gender and power relations, the increasing problem of rural landlessness, and the pandemic of HIV/AIDS. Therefore, this study takes a holistic, interdisciplinary, farming systems approach to research, appreciating that the potential adoption of grain amaranth as a livelihood strategy cannot be researched and understood without an in-depth assessment of the whole

[2] Spedding (1988: 18) has defined a system as "a group of interacting components, operating together for a common purpose, capable of reacting as a whole to external stimuli"

livelihood system, and an uncovering of household livelihood strategy decision-making processes.

The Household Level and Gender Issues

Defining the Household

The main level of focus of this study is the household. There is therefore an imperative need to define what is meant by a “household” before meaningful “household level” data collection and analysis can be done. The tendency of much development literature has been to treat the household as a stable object. However, households are dynamic, with ever-changing compositions, resources, constraints and requirements.

In addition, there has been a tendency among researchers to view the household in a unitary model, treating the household as one in which a collection of individuals behave in agreement with each other in order to maximize collective productivity towards common goals. Such models obscure different preferences and orientations within the household and do not account for aspects of power relations, such as negotiation and contestation, within the household (Aspaas, 1998; Carr, 2005; Quisumbing & Maluccio, 2000). Households are diverse, with differing compositions, and entail complex relations and interactions between individuals, therefore this unitary model of the household must be discarded (Udry, 1996).

A household has been defined as a basic social and economic unit in which individuals organize themselves for food and shelter, and may often include people who are not biologically related (Preston, 1994). In a study done among the Luo in Western Kenya, a household was defined as “a group of people who live together and eat from the same kitchen” (Nyambedha, Wandibba & Aagaard-Hansen, 2003). However, this definition does not account for all members who contribute to the socio-economic unit of

the household, including for instance those who migrate and work in other areas but send remittances back to the household. It has been proposed that the group of people who live and eat together is a sub-unit of the household, termed the “hearthhold” (Henderson, Finan & Langworthy, 1997). On the other hand, individuals who are not present but continue to contribute to or draw on the household are also considered members of the household, though not members of the hearthhold (McIlvaine-Newsad, Sullivan & Dougherty, 2003).

Households in rural Kenya cannot be thought of in the Western mindset of the nuclear family. Household members are not necessarily related by blood. Therefore, a household must be distinguished from a family, which is based on kinship, i.e. biological affiliation. The situation is complicated by complex networks of kinship relationships give rise to households that often include extended family members. Furthermore, one household may occupy more than one house, maybe even a whole compound, and so the concept of the household must not be tied to physical structures.

The assumption that the household is the most appropriate institution at which to base analyses has also been challenged (Carr, 2005). Individuals act not only under the framework of the household but through multiple social and organizational units. The household operates in a context of competing social units, and cannot be viewed in isolation from the community in which it is located. Indeed, many researchers recognize the need for a more spatially extended understanding of the household than the conventional assumption of an identifiable nuclear unit (Ellis, 1998). The household needs to be therefore viewed as part of a system that incorporates multiple levels, ranging from the individual to the international. Issues such as market supply and

demand, agricultural prices, labor and credit availability, gender relations, and coping mechanisms all transcend the boundaries of the household, yet still have significant impact upon the processes at work within the household.

So, with the household as the primary unit of analysis for this study, I contend that the household needs to be addressed not as a static object or as a single cohesive unit. Instead, I concur with Carr (2005) in the need to address the household as a "local construction that embodies flows of power and knowledge both within and transcending the local." In this study, therefore, households will be considered as dynamic entities with changing composition. I intend to uncover local constructions of what constitutes a "household" in the two communities of study, in order to focus this research on appropriate units. The important question of who is included in a household will be addressed.

Gender Issues and the Household

Gender is a social construction formed around a biological identity – sex. Development efforts frequently have been critiqued for their lack of appreciation of gender as an important factor, often referred to as gender-blindness. This critique has often been answered by following a strategy of "add women and stir," yet this normally rests on the misinformed assumption that gender is simply about women or women's issues (Cornwall, 2003). Instead, gender involves roles and relationships, and the interaction between male and female.

In Kenya today, there are traditional gender roles in rural households that have been maintained and reinforced since pre-colonial times. Most rural communities in Kenya still operate under a patrilineal system based on kinship. In this system, land and resources are passed down through the males in the family. Women traditionally have

access to these resources through their husbands or a male family member. Men's traditional role in the household has been that of the "head" and the decision-maker, although it is widely noted that women do most of the work for the household. In the home, the majority of reproduction household tasks are carried out by the women, including cooking, laundry, cleaning, and caring for children.

Rural Kenyan livelihoods are still predominantly based upon agriculture, which also has held traditional gender roles. For example, the realm of cash cropping is typically dominated by men, while that of food cropping for household consumption is usually the women's priority. There has also been a traditional gender division of labor linked to specific agricultural tasks, though this has varied between communities. Female tasks were traditionally labor-intensive – tasks that required constant labor inputs - such as weeding and transporting harvest produce from field to homestead. On the other hand, male tasks often included planting and harvesting. Therefore, gender has traditionally been an extremely significant factor in determining and defining roles and relationships amongst household members.

These gender roles and relationships, however, are not static and are always being re-created, negotiated and contested. A prime example of this can be seen in the struggle surrounding control over and access to resources, such as land. It has been estimated that 80% of all agricultural work in Kenya is done by women (KHRC, 1998). This work depends on having user rights and access to land, yet the role of women in land tenure security is typically overlooked. In pre-colonial times, women were not as tenure secure as men, as they did not have transfer rights in the customary patrilineal system. However, their user rights were generally secure, protected by community

councils (KHRC, 1998), granting women access to land through their husbands or other male relatives.

However, the land reforms initiated by the Swynnerton Plan in 1954 involving registration and titling of land have deprived women of the potential to become “owners” of land, as most land titles were adjudicated and registered under male ownership. Consequently, these men who now have title to the land in many situations have the right to sell land without needing any consent from the community or female members of their households (Haugerud, 1989). This process has contributed to weakening or in some cases eliminating women’s usufruct rights to land, as women often no longer have a strong claim to access to land through male relatives who can sell the land at their own discretion (Mackenzie, 1989).

Furthermore, under an individualized system of tenure based on a capitalist land market, theoretically women could have access to land through purchase. However, women often enter the market with no property, no title to hold as collateral, minimal cash, and minimal political power (Lastarria-Cornhiel, 1997). Under the post-colonial government, this situation has deteriorated. The Law of Succession Act of 1972 offers no protection to widows – once their husband has died they are not guaranteed any access to agricultural land, which is passed to male relatives (Aliber & Walker, 2006). Also, the passing of the 1987 Registered Land Amendment Bill confirmed the provision of title deed documents to owners of land, who invariably were mostly men (KHRC, 1998).

However, these women are not without agency. Many rural women are continuing to look toward the authority of local community elders or leaders, appealing to

customary law to help keep them tenure secure (Aliber & Walker, 2006; Quisumbing & McClafferty, 2006). There have also been numerous instances of women appealing to local land control boards in order to block sales of land that would reduce their tenure security (Haugerud, 1989). Thus, gender issues continue to be at the forefront of influencing household allocation and decision-making processes.

Although traditionally the majority of households in rural Kenya have been headed by an adult male, many authors note the increasing frequency of female-headed households. These households fall into two categories (IFAD, 2002). First, many adult males have sought wage income from off-farm sources and have become migrant laborers, sending remittances back to their household, which may be headed on site by an adult female. Such households which have an absent male head and which are subsequently headed by a female are known as *de facto* female-headed households. Secondly, there are female-headed households in which the female head is single, divorced, widowed, or separated, and these are known as *de jure* female-headed households. Thus, three types of households exist in rural Kenya – male-headed households, *de jure* female-headed households and *de facto* female-headed households (Onyango, Tucker & Eisemon, 1994; Verma, 2001).

However, care must be taken to avoid basing analysis of these households on the unitary model of the household, assuming that the “head” is ultimately the single spokesperson for the household. Francis (1998) underscores the importance of understanding the effects of gendered intra-household dynamics upon household livelihood strategies. She argues that gender interdependencies are crucial to the survival of many households in rural Kenya. She notes that the recent surge in Kenya in

intensification of commercial crop production is in particular strengthening men's need to access women's labor, while at the same time reinforcing women's need to access men's increased income from this commercial crop production. However, she argues that although this appears to be a credible view, a truer portrait of the situation may be that women's lack of power in the household is a bigger incentive for them to cooperate rather than simply their need for access to men's income. She suggests that many rural Kenyan households are being increasingly held together through women's need for marriage both to obtain access to land and also to retain custody of their children.

However, gender dynamics are more complex than simple interdependencies. Francis (1998) also highlights the importance of negotiation, bargaining, and power relations within households with reference to gender. Household members do not necessarily have the same preferences, thus individual strategies may well differ from household strategies (Quisumbing & McClafferty, 2006). With differing individual strategies, household members are drawn into a process of negotiation. The distribution of the bargaining power and resources, however, currently favors the adult men in the household (Quisumbing & McClafferty, 2006).

It is also crucial to account for and understand gendered patterns of indigenous knowledge. As men and women often operate in different environments, much knowledge concerning aspects of the livelihood system is gender-specific (Howard, 2003). Furthermore, knowledge is about power and gender relations, and this knowledge is therefore accorded status depending on to whom it belongs. Male knowledge is typically privileged over female knowledge, yet in order to fully understand livelihood systems, both must be obtained and interpreted.

Therefore, in this study, attention is paid towards identifying and understanding the varying household and gender dynamics regarding livelihood strategies. Gender roles, relationships, interdependencies, and knowledge are all important factors that relate to the household livelihood strategies that are negotiated and ultimately undertaken. This study analyzes the processes by which households balance the diverse needs and activities of their members in order to generate more realistic models of decision-making within households (Alderman *et al.*, 1995).

Amaranth

Amaranth is a crop underexploited for its grain that is receiving renewed attention (Myers, 1996). The three domesticated species of grain amaranth cultivated today are *Amaranthus caudatus, A. cruentus* and *A. hypochondriacus*. These species are widely regarded to have their origins in the New World (Early, 1990; Kulakow & Hauptli, 1994; Sauer, 1950). By the end of the 15th century, the grain amaranths *A. cruentus* and *A. hypochondriacus* were important crops in a region extending from the Guatemalan highlands, northwestward through Mexico into Arizona, whilst *A. caudatus* was cultivated in a region through the Andean highlands of Peru, south past Lake Titicaca in Bolivia, through to the temperate valleys of northwest Argentina (Sauer, 1967). Although grain amaranth was probably never a major crop in Andean regions (Early, 1990), it was one of the basic foods to the Aztecs in Meso-America in pre-Columbian times, nearly as important as maize and beans (Berghofer & Schoenlecher, 2002).

Not only was grain amaranth used as an important staple and nutritional food by the Aztecs, but it was also extensively used in rituals and sacrifices. With the arrival of Hernán Cortez and the Spanish conquistadors, the mass destruction and banning of cultivation of the amaranth plant was ordered by the European colonizers in 1517, due

to its association with pagan rituals seen to be a mockery of the Christian sacrament of communion (Meitzner & Price, 1996). This resulted in a dramatic decline in the cultivation of grain amaranth in Central America for the next 400 years, as it remained in only a few remote and isolated pockets of Mexico (Espitia-Rangel, 1994).

However, grain amaranth was not totally eradicated, and this crop has seen a resurgence of interest among the scientific community and farmers in the last 30 years, especially due to researchers re-discovering its nutritional benefits. Research into amaranth in the United States began in earnest in 1976 by Robert Rodale, who launched an extensive research program in which farmers and home gardeners alike across the States were encouraged to grow amaranth and give feedback to Rodale about optimum conditions for different amaranth species. The efforts of Rodale and the efforts of the National Academy of Sciences in promoting alternative crops (NAS, 1975, 1984), together with the realization that worldwide cereal production and use is becoming increasingly restricted to wheat, rice and maize, led to an increasing drive to look toward alternative grain crops to preserve diversity in crop production and extend the range of grain crops in human nutrition (Berghofer & Schoenlecher, 2002; NAS, 1984).

Amaranth is a pseudo-cereal – one of the few non-grasses that produces an edible “cereal-like” grain. It has been ranked highly on the “desirable” list during discussions concerning selecting alternative crop species that could help turn back the threat of famine in the tropics (NAS, 1975, 1984). However, it is not only adapted to tropical environments, but is broadly adaptable to a range of environments, and thus found throughout temperate and tropical regions of the world today.

Table 2-1. Uses and areas of origin of common *Amaranthus* species (adapted from Teutonico & Knorr, 1985)

Species	Use	Area of origin
A. blitum (A. lividus, A. oleraceus)	Vegetable, ornamental	Asia
A. caudatus (A. edulis, A. mategazzianus)	Grain, vegetable, ornamental	South America (Andes)
A. cruentus (A. paniculatus)	Grain, vegetable	Central America (Guatemala)
A. dubius	Vegetable	South America
A. hybridus	Vegetable	South America
A. hypochondriacus (A. leucocarpus, A. leucosparma, A. flavus)	Grain, vegetable	Central America (Mexico)
A. retroflexus	Vegetable	North America
A. spinosus	Vegetable	Asia
A. tricolor (A. gangeticus, A. mangostanus)	Vegetable, ornamental	Asia
A. viridis (A. ascendens, A. gracilis)	Vegetable	Africa

The genus *Amaranthus* contains approximately sixty species (Willis, 1973). Of these, only three are domesticated for grain, while several other species are used as a vegetable or as ornamentals (Table 2-1). In East Africa, amaranth is widely known and even grows wild. However, in this area it has rarely been cultivated for its grain, and instead the common species that is grown is *Amaranthus blitum*, a green leafy vegetable, known in Kiswahili as *mchicha* (Abukutsa-Onyango, 2002). When referring to it in English, many East Africans give it the name “spinach,” though it is not the spinach that we are familiar with in temperate regions. Awareness that there are species of *mchicha* that can be cultivated as a grain is very low in East Africa. However, as *mchicha* is a crop that is familiar to and often cultivated by people in East Africa, the task of introducing grain amaranth becomes not one of introducing a totally foreign crop, but one of generating awareness and reshaping attitudes towards a crop that was once considered only as a vegetable. Grain amaranths can be grown not only for their grain,

but they also can produce considerable vegetable matter. Hence, the introduction of grain amaranths can be seen as adding value to an already familiar crop, and not replacing vegetables with grain.

There are many incentives for the production of grain amaranth in East Africa. Grain amaranths (especially varieties of *A. cruentus*) that have been bred to be short in stature yet with full grain heads can reach maturity in Kenya in as little as 60-75 days (CRWRC, 2006b; Gupta & Thimba, 1992). The optimum daily maximum temperature for grain amaranth is 21°C/70°F, with an optimal germination temperature range of 16-35°C (61-95°F) (NAS, 1984), a range that matches many temperature ranges of places in East Africa. Although all three grain species tolerate high temperatures, growth ceases for *A. cruentus* and *A. hypochondriacus* below 8°C/46°F and plants are injured below 4°C/39°F. All species prefer neutral or basic soils, well-drained and not waterlogged. The essential period for water is germination and seedling establishment – after the first 21 days after planting, amaranths do well with little or no water. Although nitrogen has been identified as the limiting soil nutrient in most situations (Myers, 1998), grain amaranth can provide good yields even on poor soils. Grain amaranth is drought tolerant (NAS, 1984), making it an attractive option for East African limited-resource farmers, reliant on often-unpredictable seasonal rainfall.

Amaranth grain also promises nutritional benefits to its consumers: it is high in carbohydrates, and fat, making it an energy-rich food. It is also especially high in protein (13-19%), which is significantly higher than the protein content of major cereals such as maize (9-10%) and rice (7-10%) (Bressani, 1988; NAS, 1984). It is also high in the essential amino-acid lysine, typically low in other cereal grains (Downton, 1973). In

nutritional terms, grain amaranth has a high “chemical score” (a calculated value in which the higher the number, the more perfect the match for human nutrition) of 75-87, compared with 57 for wheat, 48 for sorghum and 44 for maize (Meitzner & Price, 1996).

The introduction of amaranth as a viable additional livelihood strategy is challenging for CRWRC, as it would be for any food crop that is not one of the main traditional crops (e.g. maize) cultivated. The challenge of introducing amaranth into rural livelihood systems is further enhanced when working with different communities. In this case, CRWRC is working with a large number of different communities with various languages, cropping systems, and traditions, across Kenya.

CRWRC has worked with partner organizations in Kenya since 1999 in the promotion of grain amaranths, especially the two of Meso-American origin, *Amaranthus cruentus* and *Amaranthus hypochondriacus*. The promotion of these species has depended upon the area of Kenya. In general, in hot, lowland areas, *A. cruentus* is being promoted, as this species is best suited to areas of elevation below 2000m (Williams & Brenner, 1995). Meanwhile, *A. hypochondriacus* is being promoted in highland areas, where temperatures are cooler. Grain amaranth is being promoted primarily as a food crop that can increase food and nutrition security[3] for households.

Although there have been research studies conducted in East Africa on the adoption of traditional staple crops, such as maize and wheat (Doss *et* al., 2003), there has been no conventional scientific research into the potential adoption of grain

[3] Food security is defined as “access by all people at all times to enough food for an active, healthy life”. (World Bank, 1986) Food security thus has two essential elements: first, the availability of food; second, the ability to access or acquire it (Nyariki & Wiggins, 1997). Food and nutrition security is an extension of food security to include the element of food utilization and absorption. Therefore, food and nutrition security can be defined as: access by all people at all times to enough food, including adequate utilization and absorption, for an active, healthy life.

amaranth in East African farming systems. In the context of this study, there is a need to bridge the gap between knowledge concerning grain amaranth production and knowledge concerning Kenyan rural livelihood systems and how amaranth might fit into small-scale livelihood systems for diverse kinds of limited-resource households. Although high levels of grain amaranth production are possible in East Africa (CRWRC, 2006b), there is no current research on whether grain amaranth production is a viable additional livelihood strategy for rural, limited-resource East African farmers to adopt into their livelihood systems. There is therefore a need to identify types of households in these systems for which grain amaranth production may be a viable livelihood strategy. Through this identification, recommendation domains for the potential adoption of grain amaranth can be outlined (Wotowiec, Poats & Hildebrand, 1988).

Agricultural Marketing in Kenya

Markets for agricultural commodities have existed for indigenous people in Kenya since before colonial times (Robertson, 1997; Van Zwanenberg, 1974). Such markets were typically barter-exchange markets, and were primarily, though not exclusively, local (Hakansson, 1994). However, with the imposition of colonial rule, agricultural marketing began to change. Much of the fertile land in Kenya was removed from the possession of indigenous populations and reserved for white settlers. Cash crops such as tea and coffee were introduced by the settlers, yet market access for the native African population was severely restricted under colonial rule through the prohibition of production and sale of cash crops (Binswanger & Townsend, 2000). Thus, while indigenous peoples continued to participate in local markets, export markets were solely in the hands of white settlers.

In the 1950s, following World War II and in response to rising unrest in Kenya, agricultural marketing began to change significantly. First, the native populations were permitted to cultivate and sell cash crops. Then, with the granting of Independence in 1963, the large process of land transfer from white settlers to native Africans advanced rapidly, especially in the fertile “White Highlands.” The commercialization of agriculture in Kenya rapidly increased through the 1960s, which contributed significantly to the average national economic growth rate of over 6% per annum (Bigsten & Ndung’u, 1992). The future appeared bright for Kenyan rural populations and their access to improved agricultural marketing conditions.

This positivist outlook however came crashing down in the early 1970s with falling terms of trade, expansionary budgets and the 1973 oil crisis, when marketing costs increased rapidly at the same time as export volumes fell (Bigsten & Ndung’u, 1992). In response, the government instituted credit restrictions and import and price controls on agricultural products. Although credit restrictions were soon lifted, import and price controls remained as Kenya endured a series of booms and busts. In 1974, rapid inflation set in, but this was temporarily alleviated by the 1976 coffee boom. However, with the return to “normal” coffee prices in 1978-80 and the second oil crisis in 1979, growth in agriculture was hindered. Through these first two decades of independence, the Kenyan government preferred foreign borrowing rather than implementing adjustments (Bigsten & Ndung’u, 1992). However, after the refusal of IMF credit in 1980 coupled with increasing debts, adjustment became a much more favorable way for the government to proceed (Kherallah *et al.*, 2000).

In the early 1980s, the World Bank and other donors adopted structural adjustment lending as a means of encouraging macroeconomic and sectoral policy reform (Ikiara, Jama & Amadi, 1992). The Kenyan government negotiated two structural adjustment loans from the World Bank in 1980 and 1982, for which in return for financial help, the Kenyan government approved a series of reforms, which have come to be known as Structural Adjustment Programs (SAPs). Under these SAPs and the recommendations of the World Bank's 1981 Berg report, significant market reforms were enacted with emphasis on liberalization and privatization (Jayne *et al*., 2002). The World Bank promoted adoption of the free market mechanism, which was seen as the most efficient way of reallocating resources (Kherallah *et al.*, 2000). The Bank also emphasized institutional reforms, as it was argued that government restrictions and control were serious constraints to economic performance. SAPs were therefore an extension of the capitalist mode of production, removing control from the government and placing it in the hands of the market.

The SAPs took two main routes regarding Kenyan agriculture. First, there was the encouragement of the quickening of the process of granting title deeds as means of institutionalizing private land ownership, viewed to be an essential system for sustained economic growth. Secondly, the SAPs pushed for the liberalization of the agricultural marketing system, especially grain markets (Bigsten & Ndung'u, 1992). These market reforms were to come about through improved market integration and especially through the removal of price distortions (Diao & Hazell, 2004).

Before the 1980s, the independent Kenyan government had retained a large measure of control over the agricultural marketing system through setting commodity

prices at fixed levels, the provision of subsidies, and protection of public enterprises. The SAPs encouraged by the World Bank implied that this strict control was hindering the efficient functioning of the agricultural production system:

There is substantial support for a view that pricing policies are a root cause of the food and agricultural crisis in Africa (World Bank, 1981). Marketing boards that controlled market prices of agricultural commodities were dismantled, and price distortions were therefore subsequently eliminated (Bryceson, 2002). There was further removal of government control and monopoly through the handing over of agricultural marketing, especially maize, under the assumption that private traders would better balance supply and demand within Kenya. Subsidies, especially those on agricultural inputs such as fertilizer, were removed by the government in an effort to “get the prices right” (Demery, 1994). Restrictions on the inter-regional movement of maize and other cereals were also removed.

The Aftermath of Structural Adjustment Programs

Kabubo-Mariara & Kirit (2002) have argued that structural adjustment “failed to create the conditions for sustainable recovery of GDP growth to levels attained in the 1960s and 1970s” (pg 2). The 1980s and early 1990s witnessed an increase in poverty in Kenya, while social indicators (e.g. life expectancy, child mortality, primary school enrollment) all had negative trends. Meanwhile, in agriculture, priorities for research and development (including donor funding) switched from remote rural areas to “high-potential” areas, based on the assumption that the returns to investment are higher (Sutherland *et al.*, 1999).

As a result, SAPs on the whole served to worsen the lot of the rural, limited-resource households in Kenya. These households were faced with increasing market

uncertainty following the removal of price controls, with wide fluctuations in prices from year to year and season to season. The removal of agricultural subsidies caused input prices to sky-rocket and inputs were thus beyond the reach of these households. At the same time, the removal of government subsidies on health and education increased these households' need for higher incomes. Private traders varied in performance through time and space, while government investment in rural public infrastructural development was low (Binswanger & Townsend, 2000).

Structural adjustment programs brought about a devaluing of Kenyan currency, which in turn resulted in the promotion of traditional export cropping, as Kenyan products became more competitive on the world market (Lamb, 2000). However, rural, resource-limited households found it increasingly hard to finance export crop production, and this production was taken up by large-scale farmers. Although fertilizers and other inputs were often still too expensive for many resource-limited households, fertilizer consumption actually increased through the 1980s in Kenya due to the increase in usage on larger farms for export cropping (Bigsten & Ndung'u, 1992). However, the promotion of and subsequent substitution of export cropping for food crop production in a country that is far from food secure has been noted to be of serious concern (Lamb, 2000).

SAPs thus encouraged the rural poor to edge away from traditional export cropping and towards diversification and experimentation, seeking ways to attain greater food security (Bryceson, 2002; Ellis, 2000). They also forced rural households to adopt new strategies to attain income, as it quickly became clear that households needed to expand their number of income earners beyond that of the adult male. This

led to a rapid increase in the informal sector, especially in rural areas, both in agricultural marketing and also other activities (Bigsten & Ndung'u, 1992). This informal sector has been especially filled by women, as they seek new strategies to get cash income.

Although on the whole the weight of evidence suggesting that SAPs have been disastrous for the rural poor in Kenya appears large, there are other factors to consider, which are often neglected. SAPs coincided with not only periods of extensive drought in Kenya in both 1979/80 and 1983/84 that negatively affected agricultural production and led to massive food imports, but also with an attempted military coup in 1982, which adversely affected foreign investment (Kabubo-Mariara & Kirit, 2002). It has been recently argued that it is difficult to determine whether the negative impacts witnessed are the result of the failure of structural adjustment policies or in fact due to the failure of government and its reluctance to implement reforms (Jayne *et al.*, 2002). Evidence of this "failure" of government includes the poor management of grain reserves through irrational exporting, corruption and mismanagement of cereal institutions, and the lack of willingness to remedy the problem of poor and inadequate crop storage facilities.

Current Issues

The impact of the period of structural adjustment upon agricultural production and marketing continues to have profound effects into this century. This impact has been compounded by downward trends in world prices on traditional export crops (coffee, tea, sugar, tobacco, cotton & cacao), which contribute 50% of Africa's total agricultural exports. As a result, many farm incomes have fallen, and even where farm incomes have risen (especially on large-scale farms), this rise has been small (Diao & Hazell, 2004). Agricultural production in Eastern and Central Africa remains low, growing at just

2.34% between 1993 and 2003, less than the 3% population growth rate, indicating a decline in per capita agricultural production over this period (Bahiigwa, 2006).

There is therefore a need to increase agricultural productivity, but this could depress commodity prices and farm incomes if farmers are not linked to market opportunities. Currently, many rural markets remain underdeveloped and most smallholders who live away from roads and markets have not benefited from any of the structural adjustment reforms. However, this situation is likely to change with increasing investment in rural infrastructure. One such example is the Kenyan rural electrification program, initiated by the government in the mid 1990s. In bringing electricity to many rural areas, new practices are available, such as long-term storage and refrigeration of agricultural produce, allowing farmers to market their produce when they are ready and not only right after harvesting.

However, market competition is still a major problem facing Kenyan farmers. In domestic markets, they face competition from subsidized imports of staple foods, especially wheat (Diao & Hazell, 2004). In international markets, agricultural marketing is constrained by trade distorting practices in developed countries, such as tariff peaks, tariff escalation, domestic support to their farmers, and export subsidies (Bahiigwa, 2006). It has thus been argued that Kenya would gain more from liberal trade policies than international aid (Bahiigwa, 2006; Binswanger & Townsend, 2000).

Furthermore, rural, resource-limited households face the overwhelming constraint of receiving a low producer price for their commodities (Binswanger & Townsend, 2000). Households typically only get 10-20% of the market value for their products, as 80-90% is lost on transport and marketing costs. The cash costs of production,

however, are low and by improving transport and marketing infrastructure the Kenyan government would greatly increase the availability of relatively cheap agricultural commodities to offer in domestic and international markets.

Bahiigwa (2006) has presented some possible ways forward for rural, resource-limited households. He has argued that these households currently stand to gain more from investing in agricultural commodities consumed within the region than from traditional export crops. Another promising opportunity that he proposes is for households to exploit niche market opportunities for product differentiation (e.g. specialty coffees) or non-traditional exports (e.g. vegetables and fresh cut flowers).

Agricultural Marketing and this Study

The primary agricultural focus of rural, resource-limited households in Kenya is food security. However, agricultural marketing of produce, whether cash crops, surplus subsistence crops, or livestock, is also an important factor. This marketing takes place in a variety of forms, which are crucial to identify. There is a range of scales of markets, running from the local village markets, which may be held as frequently as every day, to global export/import markets. This range also therefore implies different quantities of products, ranging from individually countable numbers of products in the village setting to bulk shipments at the international level. Encompassed within this discussion of scale is the notable distinction between rural and urban markets within Kenya. Whereas rural markets most likely offer commodities fresh from the field (*shamba*), urban markets often require higher quality product standards. Rural, resource-limited households may not be able to benefit from these urban markets due to their lack of training and organization to meet these standards demanded by supermarkets and urban consumers (Bahiigwa, 2006).

It is also important to identify gender issues in agricultural marketing in Kenya. Local markets tend to be solely in the female domain, consisting of subsistence produce brought from the household's home-garden or fields that the adult female is in charge of managing (Momsen, 2004; Aspaas, 1998). These markets often involve only limited cash transactions, and barter-exchange is a common method of transaction. These markets are typically informal, and often act as a social event as much as a marketing event. Male involvement in agricultural markets increases as the level of cash-flow increases. Men are more likely to be involved with the marketing of cash crop produce, which also typically operates on a larger scale than the local markets. These markets are more formal and business-like, and often involve pre-agreed contracts on quantity, quality and price of products.

Central to all these discussions of marketing are commodity price issues. Since the liberalization of markets under SAPs, agricultural commodity prices have fluctuated enormously. This aspect of marketing is likely to be a significant factor affecting the potential adoption of grain amaranth, especially in cases where households aim to cultivate amaranth for cash sale as well as or instead of for home consumption. Prices of grain amaranth and other agricultural commodities are likely to vary seasonally as well as annually in response to demand and supply constraints. With the current crisis in Kenya, insecurity has increased forcing increases in transport costs in particular. The price situation of agricultural commodities is thus an important burning issue in the context of rural livelihood systems. The issue of marketing of grain amaranth as well as other agricultural commodities will be carefully considered in this study, to assess whether grain amaranth has a future as a food crop, a cash crop, or both.

HIV/AIDS

Human Immunodeficiency Virus (HIV) is a vigorous retrovirus that leads to Acquired Immunodeficiency Syndrome (AIDS), a condition in humans in which the immune system is negatively affected and ultimately fails due to opportunistic infections. There is currently no known cure or vaccine available for HIV. HIV infection is transmitted by the transfer of bodily fluid between humans (blood, semen, vaginal fluid, or breast milk), and the most common routes of transmission are sexual intercourse, breast milk, mother-to-baby at birth, and contaminated needles or syringes (CDC, 1999). The transmission of HIV via blood transfusion has now been substantially reduced with the screening of blood for HIV.

The Typical Course of HIV Infection

HIV primarily infects the immune system by infecting vital CD4+ T cells. These cells are crucial in maintaining the immune response in humans to infections. HIV infection, however, rarely leads to sudden death, but with increasing viral load through replication of HIV, eventually the immune systems of infected persons collapses and becomes increasingly susceptible to opportunistic infections which the immune system can no longer fight. The progression of HIV in a person can be viewed epidemiologically in three main phases (Figure 2-1). First, there is the phase of initial infection, often referred to as the “acute” phase, which is characterized by a rapid decline in CD4+ T-cells and a rapid replication of HIV. In this time, CD8+ T-cells are activated and begin killing off the virus. This phase is associated with a diverse range of symptoms, which makes HIV infection difficult to identify without an HIV-test. Most common is the development of flu-like or mononucleosis-like symptoms.

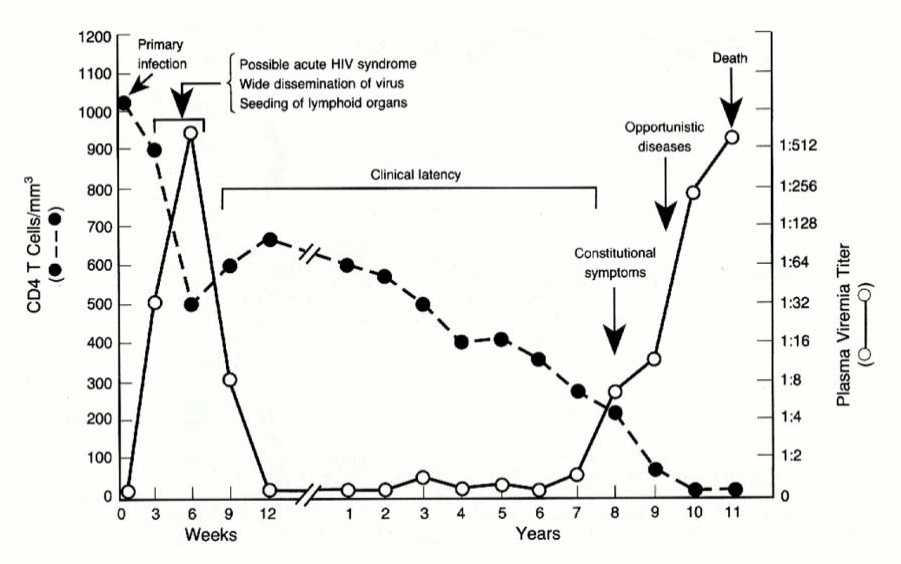

Figure 2-1. The typical course of HIV infection (from Pantaleo, Graziosi & Fauci, 1993)[4]

After an average of four weeks, CD4+ T-cell counts typically rebound to around 800/ml (the normal range is around 1000/ml), and most individuals move into the second phase, known as the clinical latency phase. This phase is typically asymptomatic and typically lasts around 6-8 years, but can last anywhere between 2 weeks and 20 years. Although the majority of HIV is killed off by the CD8+ T-cells, the virus becomes trapped in some areas of the body, especially in the lymphatic system. Over this phase, CD4+ T-cells decline steadily, slowly increasing the individual's susceptibility to opportunistic infections.

The third and final phase of HIV leads to AIDS. AIDS is defined as the presence of HIV infection, plus one or both of the following: (i) a CD4+ T-cell count of less than 200/ml; (ii) development of an opportunistic infection that occurs when the immune system is not working correctly, of which *Pneumocystis carinii* pneumonia (PCP), tuberculosis, and some specific tumors such as Kaposi's sarcoma are common. AIDS

[4] "Plasma Viremia Tier" on right-hand-side y-axis, is equivalent to "HIV viral load"

ultimately leads to the death of the individual. The length of time of this final phase depends on the CD4+ T-cell count of the individual and the strength of the immune system in warding off opportunistic infections.

HIV/AIDS in Kenya

Although sub-Saharan Africa has only 10% of the world's population, it is home to more than 60% of the world's people living with HIV/AIDS (UNAIDS, 2007b). Kenya is no exception, despite recent data suggesting that the epidemic is beginning to decline amidst evidence of changing behaviors (UNAIDS, 2007b).

HIV is spread primarily by heterosexual contact in sub-Saharan Africa, and is the only place in the world where women are infected with HIV at a higher rate than men (UNAIDS, 2007b). Indeed, HIV/AIDS is a strongly gendered disease. It has been documented that across the world, women are both biologically and socially more at risk of HIV infection than men (Farmer, 1996; Gillespie & Kadiyala, 2005). Biologically, male-to-female transmission rates through sexual intercourse, the most common route of HIV transmission, are greater than those of female-to-male (Padian, Shiboski & Jewell, 1991). However, it is argued that the AIDS pandemic among women is strikingly patterned along social, not biological, lines (Farmer, 1996). These social lines are bound up with economic inequalities, often reinforced through structured cultural relations. In many areas of the world, both in developing and developed countries, women in poverty face higher risk of HIV infection than those who are of higher socioeconomic status. Poor women are more exposed to structural power relations, in which issues of male power and choice makes these women often unable to negotiate safe sex practices even when condoms are available. Many poor women may be faced with prostitution as the only way of getting income, which greatly increases their

vulnerability to HIV. Furthermore, in many areas of the world, women lack power and control over the sexual lives of their husbands (Haram, 1995). Those women who do try to speak out and challenge the power relations may well face the threat of sexual violence, hence increasing their susceptibility to HIV infection (Farmer, 1996). It has also been argued that in many developing countries, the high rates of unemployment are undermining the social value of men. This is resulting in increasing male frustration, borne out in patterns of sexual violence upon women (Silberschmidt, 2001). Overall, gender inequity shapes power relations and access to resources and opportunities, making HIV/AIDS a gendered, social phenomenon just as much as a global pandemic (Gillespie, 2006).

Therefore, appreciating that HIV/AIDS is more than simply a biological event, it becomes clear that the impacts of the spread of HIV infection are wide and far-reaching. The majority of households in Kenya are impacted in some way by HIV/AIDS. Despite this, there are very few studies of the impact of HIV infection upon rural household livelihood systems in Kenya (Yamano & Jayne, 2004). There is therefore a need to expand the work in this field of research.

Jayne, Mather & Mghenyi (2006) have highlighted that most attempts so far to assess the impacts of HIV/AIDS on livelihood systems in sub-Saharan Africa have been theoretical, lacking direct empirical evidence. General statements in the literature often rely on the assumption that sickness and death as a result of HIV/AIDS causes severe financial and labor constraints on a household, resulting in lower area cultivated and an increasing shift toward lower value food crops, and away from higher value potential cash crops. However, such sweeping statements disguise the wide variation in impacts

from and responses to HIV/AIDS (Murphy, Harvey & Silvestre, 2005). Discussion of impacts of HIV/AIDS in “the Third World” or even “Africa” have been rightly criticized for their broad generalist statements, when there is an urgent need to understand the diversity and complexity of HIV/AIDS impacts upon livelihood systems in specific, observable contexts (Treichler, 1999). It is therefore important to address this complexity by looking at a wide range of variables, including who falls ill and when, their role in the household and society, household composition, and coping mechanisms available and enabled by the household. The degree of the impact of HIV/AIDS upon a rural household depends upon a range of social variables, including socio-economic status, gender, ethnicity, and cultural traditions (Barnett & Whiteside, 2002; Binswanger, 2006).

When talking about the impacts of HIV/AIDS upon individuals and households, it is clear from the discussion of the typical course of HIV infection that HIV is unlike many other sicknesses in that it takes multiple years to progress. The impacts upon a household of HIV infection of an individual are thus going to be felt across a prolonged period of time. A study of HIV-infected individuals in rural East Africa has estimated the average time from seroconversion (becoming HIV+) and death from AIDS to be 9.8 years (Morgan *et al.*, 2002). Another important point is that HIV infection has distinct phases. Therefore, the impacts of HIV infection of an individual will vary depending on where the individual is in terms of HIV progression. Households are likely to be strongly impacted in the initial phase, while during the asymptomatic phase, impacts may be significantly reduced until the latency period draws towards the final phase, that of AIDS, when impacts upon a household would likely peak.

Much of the current literature on the impact of HIV/AIDS upon livelihood systems focuses upon the many negative effects of HIV infection. Although the HIV virus attacks individuals, it has long been noted that the spread of HIV/AIDS is much more than a physiological happening; it has wide-ranging social ramifications (Ankrah, 1991; Haddad & Gillespie, 2001; Kaijage, 1997). Gillespie & Kadiyala (2005) have indicated the important need to consider HIV/AIDS within the complete context of livelihood systems (Figure 2-2). In this way, the cyclical nature of the effect of HIV/AIDS upon livelihoods, and of livelihoods upon HIV/AIDS can be considered.

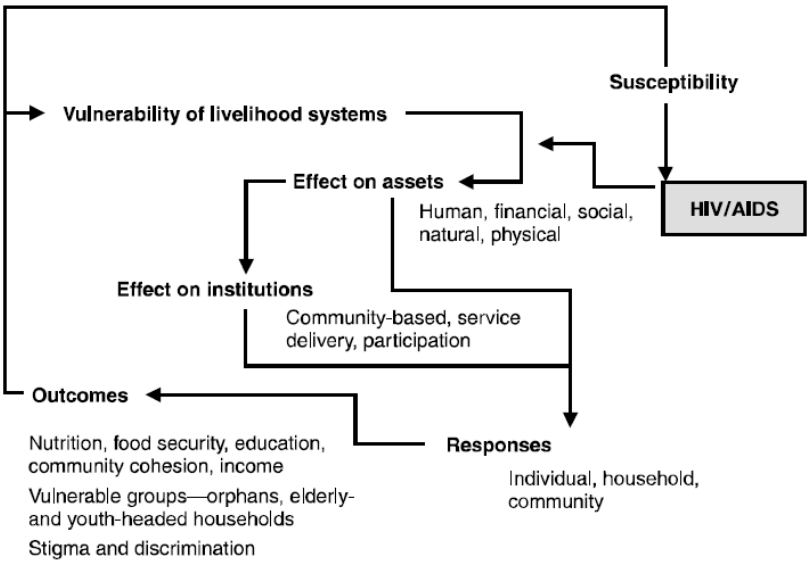

Figure 2-2. Understanding HIV/AIDS in the context of people's livelihoods (from Gillespie & Kadiyala, 2005)

One of the most significant impacts of HIV/AIDS upon a household is the loss of available labor of the HIV-positive (HIV+) person. Recent estimates suggest that up to two years of total labor may be lost from a household due to the individual who is sick and is unable to perform tasks, and also due to those who care for the sick individual (FAO, 2003). Care-givers are also typically female, thus tasks normally performed by

women in a household are at risk of being neglected whenever anyone, male or female, is sick (ICRW, 2003; Farmer, 1996). Tasks performed by women in rural Kenyan households typically involve cultivating food crops and taking care of reproduction activities, such as laundry, cleaning and cooking. Time used in care-giving thus takes away from other important activities, increasing the risk of increased food insecurity. In rural Kenya, it is also common for those who get infected with HIV in urban areas to return to their rural home when very sick to seek care. Care-giving is therefore also extended to such household members, at the added cost of a lack of remittances sent from urban employment as well as another mouth to feed.

As HIV/AIDS is most commonly transmitted sexually, those of working age are most at risk of HIV infection. HIV infection thus most affects those who provide the bulk of the labor to the household (Barnett & Whiteside, 2002; Kaijage, 1997; Mukiza-Gapere & Ntozi, 1995). Yamano & Jayne's (2004) study on the impact of HIV/AIDS on working-age adults in Kenya showed that the while the loss of female labor resulted in less cereals and other food crops cultivated, the loss of male labor was more severe upon the household. The loss of male labor led to less cash crops being grown, resulting in a loss of income to the household. Furthermore, the loss of an adult male head of household in rural Kenya often also results in reduced land tenure security for the household. Thus, the potential loss of land and lack of cash for households losing a male adult can be much more significant than simply the loss of labor (Gillespie, 2006). This issue was also explored by Thangata (2002) in his study of potential agroforestry technique adoption by rural households in Malawi. His research demonstrated that the reduction in available labor as a result of sickness of a household member depended on

household composition and who in the household contracted HIV. His study highlighted that the impact of an adult male head of household contracting HIV in rural Malawi was more severe than if an adult female had contracted HIV. In the case of an adult female contracting HIV, Thangata predicted that a household would reduce its cultivated area, but would still be able to meet its food requirements. However, in the case of an adult male contracting HIV, a 30% reduction in food intake by the household was required to cope with the shock.

Impacts are felt beyond the generation of those of working age. Infant mortality has risen in many parts of East Africa due to HIV transmission from mother to baby. Sewankambo *et al.*'s (2000) study in Rakai, Uganda, showed that infant mortality was 225 per 1000 for children born to HIV positive mothers compared with 98 per 1000 for children born to HIV negative mothers. The loss of household income and the need for additional labor when a household member falls sick often results in the loss of the chance of formal education for children (Barnett & Whiteside, 2002). Also, there are a growing number of households that are missing a generation, with households composed of entirely older adults and their orphaned grandchildren. This generation gap can result in a loss of indigenous technical knowledge (ITK) and it is argued that in this context kinship-based structures of support are being overwhelmed (Nyambedha *et al.*, 2003). Support structures are under strain not only due to the above mentioned impacts, but also through stigma that is linked to HIV/AIDS. Differentials in stigma experience vary across space and time dependent upon social identities and attitudes (Alonzo & Reynolds, 1995). HIV-infected individuals and HIV/AIDS-affected households may be marginalized by their community through fear of HIV, and this can breed a

climate of blame in which grief, shame, and solitude may reign. Thomas (2006) has noted how stigma can contribute to intra-household tension and the breakdown of social support networks.

However, countering these negative impacts, much of the current literature neglects the effects of positive responses to HIV infection of a household member. Gillespie & Kadiyala (2005) have noted that there exists a myriad of different responses, differing in effectiveness and sustainability. What is important to note is that the negative impacts of HIV/AIDS are not simply absorbed by passive, static households and communities, but these impacts are acted upon in turn. Crucial to an understanding of the impact of HIV/AIDS in rural East Africa is the response of kinship networks. Kaijage (1997) has noted that the kinship system has mechanisms for care and support of households. For example, members of the extended family network may be brought in to help a household which has an HIV-infected person. Although these extra members will be more mouths to feed in the household, this may well be more than offset by the additional labor they have to offer to the household (Binswanger, 2006). There are also examples of expressions of community solidarity through support groups, such as those based on religious affiliation, which may lend support to those of the same community of faith (Dilger, 2007; Klaits, 1998).

Although global response in providing access to antiretroviral (ARV) drugs in sub-Saharan Africa has been slow, there is increasing evidence that in some areas this is changing. As of June 2005, there were 500,000 people living with HIV in sub-Saharan Africa who had access to ARVs (WHO, 2005). HAART (highly active antiretroviral therapy) is thus increasing, reducing morbidity and mortality due to AIDS among those

who are HIV+ (Wools-Kaloustian *et al.*, 2006). Recent studies indicate that HAART leads to an increase in working hours of 35% within the first 6 months of treatment for those living with HIV (Thirumurthy, Zivin & Goldstein, 2006).

Work by the International Food Policy Research Institute's (IFPRI) RENEWAL program has highlighted the promising impact of short-term food and nutrition interventions for households affected by HIV/AIDS in Western Kenya (Wagah, 2005), through organizations such as AMPATH (Academic Model for the Prevention and Treatment of HIV/AIDS). AMPATH, in conjunction with Moi University in Eldoret, Kenya and the University of Indiana, is a system of HIV/AIDS control that now reaches several million people in Western Kenya (Quigley, 2009). It delivers holistic treatment and prevention services in 19 hospitals and rural health centers administered by the Kenyan Ministry of Health. It is currently estimated that AMPATH delivers care to more than 55,000 people, in the form of HAART, community mobilization, food distribution and harvest initiatives to secure food, family preservation initiatives to secure income, and counseling and support groups (AMPATH, 2007).

With help from the World Food Program, AMPATH currently supplies food support to people living with HIV in the first year of HAART. However, IFPRI's RENEWAL program has highlighted the urgent need to explore long-term livelihood strategy options that have the potential for improving household food and nutrition security to mitigate the impact of the pandemic (Byron, Gillespie & Nangami, 2006). Food security, especially good nutrition, is essential for people living with HIV regardless of whether they are taking ARVs (Castleman, Seumo-Fosso & Cogill, 2004). However, for those who are taking ARVs, good nutrition improves the effectiveness of

treatment. In turn, food insecurity often prevents individuals from overcoming the initial symptomatic phase of HIV, making ARV treatment less effective (Mamlin *et al.*, 2009; Byron *et al.*, 2006). A recent study showed that well-nourished individuals taking ARVs are more likely to live longer than malnourished individuals on the same treatment (Paton *et al.*, 2006). Despite this, many HIV/AIDS-affected households remain stuck in a vicious cycle of malnutrition (Figure 2-3). The World Health Organization has stated that for HIV+ household members to remain productive in their livelihood strategies, a 10% increase of energy intake is needed for each HIV+ household member (WHO, 2003). Options are therefore needed to help these households break out of this cycle, especially as HAART is more effective when those with HIV are well-nourished (Gillespie & Kadiyala, 2005).

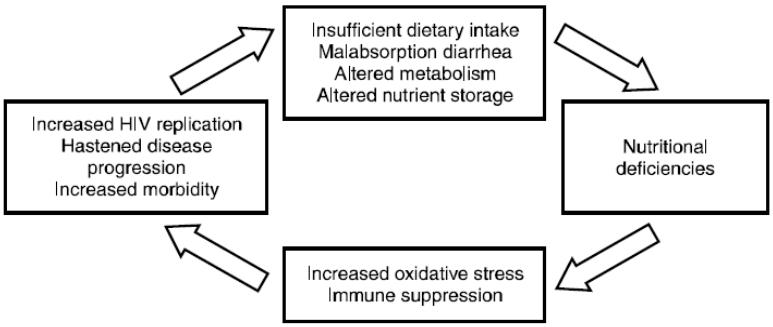

Figure 2-3. The vicious cycle of malnutrition and HIV (from Semba & Tang, 1999)

The inclusion of grain amaranth as an additional livelihood strategy option to improve nutrition of HIV/AIDS-affected households may be a way for these households to break this cycle. It has already been noted that grain amaranth provides high levels of protein, energy, and fat which can supplement diets and help maintain immune systems, even when access to HAART is limited (Haddad & Gillespie, 2001). Currently, there is no published literature on whether households with HIV+ members are able and

willing to adopt grain amaranth production as an additional livelihood strategy. This study aims to help understand the complexity of the interactions of HIV/AIDS with the livelihood systems of two Kenyan communities. With promotion of grain amaranth already underway in these communities, there is an urgent need to assess the competing influences of both negative effects and positive responses to HIV/AIDS upon the potential adoption of grain amaranth by diverse rural, resource-limited households.

CHAPTER 3
METHODS AND MATERIALS

Introduction

In the previous chapter, issues surrounding this study were presented and discussed, including agricultural research and extension in Kenya, gender issues and the household level, agricultural marketing in Kenya, HIV/AIDS, and amaranth. This chapter builds on the first two chapters by presenting the methods used to address the four research questions, which were again:

1. What are the current livelihood systems of the two communities (Amukura and Mwatate) and the current livelihood strategies adopted by diverse households within these communities?
2. What are the attitudes towards grain amaranth in Amukura and Mwatate?
3. For which kinds of household is grain amaranth production a feasible livelihood strategy option in these communities?
4. What is the impact of HIV/AIDS upon the potential adoption of grain amaranth as a livelihood strategy by diverse households in these communities?

This chapter covers the research design and methodological framework, the sampling and data collection methods employed in the field, and the analysis method used in both Kenya and upon return from the field. Finally, the chapter addresses issues of internal and external validity of the study.

Research Design

The research design employed for this study is a comparative case-study design. A case study has been defined by Yin (2003:13) as:

> an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident

Essentially, therefore, a case study is an in-depth examination of an individual unit of study in order to understand and describe a phenomenon. The unit of study for this

research was the livelihood system of a rural, resource-limited Kenyan community. This study examined two of these systems in detail in order to describe and understand the livelihood decisions that farmers make in these communities, and in particular to assess the potential for households in these communities to adopt grain amaranth as a livelihood strategy. This research study was comparative in the sense that two distinctly different communities were selected for study – one in western Kenya, and one in eastern Kenya. These communities differ in many significant ways including location, climate and culture. However, these communities are similar in the sense that both have been exposed to grain amaranth promotion efforts by CRWRC partner organizations, and both communities reflect the types of diverse rural communities in which CRWRC partners are continuing to expand their promotion of grain amaranth. Through the use of such a comparative design, factors that are distinct as well as those that are common to both livelihood systems were drawn out in assessing the potential adoption of grain amaranth by rural, resource-limited households.

Methodological Framework

The collection of information and data for this research was undertaken using multiple rapid and participatory methodologies developed within Farming Systems Research (FSR) (Collinson, 2000). FSR emerged from field practitioners in the 1970s who were working with small, limited-resource farmers when the focus of development organizations was on the provision of basic needs. From field research on farming systems, these practitioners noticed the complexity, diversity, and unique problems of these small-scale, resource-limited farms (Chambers, 1994a). FSR initially emerged as a set of essentially “bottom-up” strategies developed by these practitioners to tackle these problems (Collinson, 2000). These strategies begin and end with the farming

family and the livelihood system, in which the farm, not the research center, is the central location (Dixon, Gulliver & Gibbon, 2001).

The FSR approach was characterized by adopting a holistic standpoint, in viewing the farm and its interconnected system as a whole (Dent & Thornton, 1988). This approach also encouraged active participation of farmers in the research process, such as through experimentation and feedback (Norman, 2002). This approach adopted multiple strategies, and FSR has therefore been defined by Collinson (2000:1) as:

> …a diagnostic process; a basket of methods for researchers to elicit a better understanding of farm households, family decisions and decision-making processes…

Many models have been described as potentials for FSR methodology. These include the farmer-back-to-farmer model (Rhoades & Booth, 1982) and the farmer-first-and-last model (Chambers & Ghildyal, 1985), which emphasize the need for cyclical models of research. These models have attempted to replace the conventional linear model of research, which view research as a one-way process from researcher to farmer.

Bastidas (2001) has outlined a systematic model of FSR methodology, which was used in this research (Figure 4). This model also highlights the cyclical nature of FSR, with a need to start and end with diverse farm households. This research started with these diverse households, and by using a range of participatory methods, field data was collected and then applied using Ethnographic Linear Programming (ELP), a tool that was used to analyze household decision-making processes within the context of a livelihood system. ELP was also used to test alternatives to the livelihood systems of Amukura and Mwatate, including the introduction of grain amaranth and the impact of HIV infection of an adult household member. The testing of these alternatives fed into

the development of policy recommendations for diverse households within these two communities.

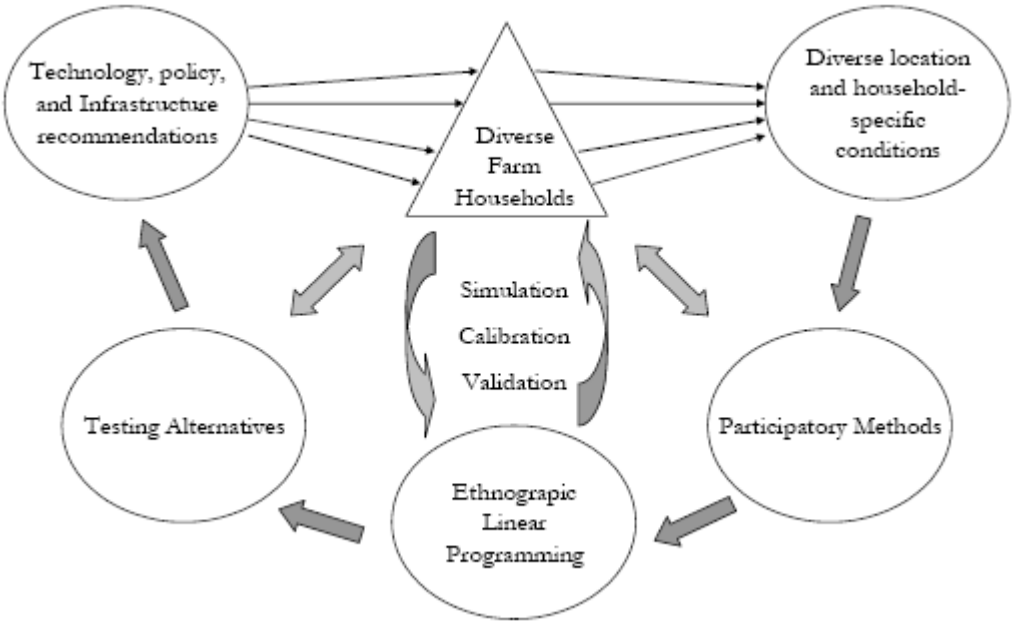

Figure 3-1. A methodological framework for Farming Systems Research (from Hildebrand & Schmink, 2004, adapted from Bastidas, 2001)

Data Collection

Primary data collection was carried out between May and June 2007 and between May and July 2008. In both communities, the methods of data collection were the same. The first part of this research study involved gathering information concerning the livelihood systems of the communities. By collecting ethnographic data on the livelihood system using participatory techniques, a basic framework of this system was drawn up and understood. Collecting these data helped in answering the first research question. This part of the data collection was the most time consuming, as these data provided a framework from which to begin to answer the other three research questions. These data were collected using two participatory techniques – informal semi-structured

interviews with rural households and focus groups conducted with the aid of various participatory tools.

Using a Participatory Approach

When stating that this research used “participatory” techniques, it is necessary to be clear as to what exactly is meant by participation in this context. The use of participatory techniques is becoming increasingly widespread in research and development practice (Thomas-Slayter, 1995). The term “participation” in this context typically refers to active participation of all people in the research and development process. However, participation is a widely-used and frequently misused or abused term, and does not always refer to active participation. Indeed, Pretty (1995) has outlined several different forms of participation ranging from “manipulative” participation, in which participation is simply a pretence, to “self-mobilization,” in which people participate by organizing themselves and taking initiatives to bring about change.

Chambers (1994a: 953) outlined one particularly popular way of using participatory methods when elaborating on what he termed Participatory Rural Appraisal (PRA), describing PRA as:

> …a family of approaches and methods to enable rural people to share, enhance, and analyze their knowledge of life and conditions, to plan and to act.

PRA emerged in the 1990s from many sources, the most direct of which was Rapid Rural Appraisal (RRA), a popular philosophy and approach for field data collection through the 1980s (Carruthers & Chambers, 1981). Disillusioned with conventional questionnaire surveys and their results, many field practitioners began to seek more cost-effective and quicker methods for appraising rural conditions. RRA thus emerged as a form of farming systems research in which outsiders collected data from

communities and then took this information to be analyzed elsewhere (Chambers, 1994a). Although RRA is primarily a set of extractive research techniques, it emphasizes the active participation of the communities in the generation and collection of data. PRA also shares this same principle of active participation. But although PRA has a lot in common with RRA, information is more generated, analyzed, owned and shared by local people in PRA compared to the eliciting and extracting of information through data gathering in RRA. However, as Chambers (1994a) has pointed out, in practice there is a continuum between RRA and PRA.

The methodological approach of this research study lies on this continuum, most probably towards the RRA end, as time was limited in the field, and much of the data were extracted and analyzed away from the field sites. However, as much as possible, this research also drew on elements of PRA, in particular through the generation of shared information within the communities and the sharing and handing over of the findings of the research to the communities. Such an approach has been described as the “virtual participant” model (Leach, Mearns & Scoones, 1997). In this model, the researcher is self-critical and explicitly recognizes his/her identity, biases, and interpretations, and the impact that these have upon the framework of analysis used. However, this stance does not prevent the researcher from reflecting, analyzing and interpreting. Thus, it is argued that the model of the researcher as a virtual participant can lead to new opportunities of learning rather than leading to biased results. Smucker *et al.* (2007) have argued that this model is different from purely extractive methodologies, such as RRA. This model emphasizes the importance of understanding divergent narratives offered by community members, the need to discuss research

findings and interpretations with communities, and the benefit of returning research results to communities to provide them with useful information.

Participatory methodologies such as RRA have been in operation in Kenya since at least the late 1980s (Kabutha, Thomas-Slayter & Ford, 1993). They are proving to be more popular with researched communities, and greater reliability of results can be achieved through the use of multiple methods (Chambers, 1994b; Chambers, 1994c). This study used a variety of participatory methods that have been outlined in the literature and used in a variety of research and development settings around the world.

Semi-Structured Interviews

The primary method of data collection used at the household level was the semi-structured interview based on the Sondeo (Hildebrand, 1981). A Sondeo is an informal, conversational-style semi-structured interviewing methodology used in the field as a rapid participatory assessment (Hildebrand, 1981). Sondeo methodology was a precursor to other participatory methodologies such as Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA), and was eventually incorporated into Farming Systems Research-Extension (FSRE), an overarching set of methodologies designed to develop improved technologies for small-scale farming systems.

A Sondeo is often utilized as the first step in gathering information from the field before other tools and techniques are employed. Sondeos are usually carried out by multi-disciplinary teams typically of 9-12 persons, yet the principles of a Sondeo methodology can be adopted by smaller teams or individuals (Breuer, 2000). A wide range of information can be obtained through a Sondeo, and this information can be both qualitative and quantitative. A Sondeo is a useful tool when time and budgetary constraints for research exist, such as for this research study. Although initially

developed more than 35 years ago, the Sondeo is still a relevant and useful tool in farming systems research today. It has been recently used with farmers in Central Kenya, highlighting its cultural applicability and adaptability to the Kenyan rural setting (Davis, 2004).

Conducting a Sondeo is a survey process yet it does not use a structured survey tool. In this way, the researcher shares the leadership of the interview with the respondent by allowing flexibility in the path the conversation takes. Meanwhile, the researcher facilitates and guides the discussion, perhaps following a pre-determined list of topics to discuss to gather the information required (Franzel, 1986). This enables conversations in the field to bring in information that the researcher might otherwise have not discovered, had he/she been restricted to a formal survey instrument (Chambers, 1997). However, by having a list of topics in mind, the researcher can still obtain reliable and consistent data (Davis, 2004). Four different topic guides were used in this study (Appendix), one for each research question. These topic guides contained a variety of open-ended questions that would help to lead conversations with individual household members and generate discussion about certain topics. By using topic guides, household members were allowed to discuss anything and everything they deemed relevant. By using a Sondeo approach with the aid of topic guides, a rich quantity and depth of information on households' circumstances within a livelihood system was able to be generated in a relatively short period of time (Rhoades, 1986).

This approach was considered to be more useful for this setting than using a conventional survey instrument, such as a questionnaire. In the two communities, literacy could not be taken for granted. Therefore, conventional questionnaires might

have ended up being filled out by the one literate member of the household for all other members of the household, possibly without their consultation. Furthermore, the active involvement of both the participant and the researcher in the face-to-face gathering of information served to increase the reliability of the data. When conventional surveys are delivered to community members and asked to be returned, it could be tempting for the household head to fill out surveys without consulting other members of the household, or for some people to fill out more than one survey by “helping” their neighbor or friend with the completion of the survey instrument. This argument is often countered by the privacy and anonymity that is often guaranteed by the use of conventional surveys, allowing respondents to feel more able to state their true feelings. However, through building trust and rapport in the Sondeo process with the interviewee, a non-threatening, open environment was facilitated in which hopefully more information was generated than a questionnaire would have allowed.

When conducting a Sondeo with individuals or households, because a statistical analysis was not anticipated, a formal random sampling using a sampling frame was not the most appropriate method used to select sample units. Instead these units were selected using informal purposive sampling techniques (Franzel, 1986). In this study, a purposive technique known as referral sampling was used, in which households were recommended to the researcher by key informants in the community. Links with the partner organizations in the field along with connections made with key figures in the community were utilized to identify and refer the researcher to a diverse set of households with which the semi-structured interviews could be conducted. Research

participants themselves in these households were asked to identify further households with which semi-structured interviews could be conducted.

Sixteen households in each community were identified and interviewed. Interviews were conducted with the head of the household, and also with other adult members of the household, dependent on the permission of the household head and time constraints. Although interviews were primarily conducted in English, these interviews also made use of a translator for household members who did not speak English. This translator was someone from the local community who knew English, Kiswahili, and the local language of the community. By working with a diverse set of households, data on a wide range of available livelihood strategy options was gathered following the topic guide for Research Question 1. By working closely with each household, information regarding the livelihood system was obtained, including input and output coefficients needed for Ethnographic Linear Programming (as described later). Also, important ethnographic and socio-economic data were obtained on the household as well as information regarding the livelihood strategies chosen by the household.

Before assessing the potential adoption of grain amaranth by households within each community, it was important to investigate attitudes towards the crop. Topic guide questions for Research Question 2 helped to uncover how amaranth is perceived by community members, and to explore whether or not it was likely to be accepted as a possible livelihood strategy. This led to further discussions involving grain amaranth – the key focus of this study - including household awareness, knowledge, and experience with the crop, following the topic guide for Research Question 3. Through

these discussions, a range of agronomic and socio-economic data was collected concerning grain amaranth production in these communities.

Discussions also sought to uncover the impact of HIV infection of a household member upon livelihood strategies adopted. In particular, focus was put on how household responses to HIV/AIDS differ from responses to other illnesses. Facilitating these discussions required sensitivity due to the nature of the topic. Data collection on issues surrounding HIV, still highly-stigmatized, was entirely voluntary in nature. Therefore, topic guide questions for Research Question 4 were framed in general terms so that household members could talk about the impact of HIV/AIDS on a typical household in their community. Households were in no way encouraged to discuss their own experiences, impacts and responses to HIV/AIDS, thus those who did not wish to speak about the impacts of HIV were under no compulsion to do so. No information was requested from participants as to specifics of HIV/AIDS itself, and no medical records were sought.

The following participatory tools were used to aid data collection:

Livelihood analysis (Chambers, 1994a) or Activities, resources & benefits analysis (Feldstein & Poats, 1990; Slocum et al., 1995). This tool was used to help generate detailed information about the livelihood strategies of households. This method incorporated the drawing of a household seasonal calendar - the same methodology as undertaken with the focus groups. By allowing individual households to draw up their own seasonal calendar, variations from the community seasonal calendar were noted. This process also served as a means of validating the findings in the community seasonal calendar. Seasonality of production, reproduction and community activities were noted, as well as seasonality of labor, cash flow, and other constraints. The use of the livelihood analysis methodologies also incorporated an analysis of the seasonal calendar through resources and benefits analysis. This analysis was used to uncover patterns of resource use and decision-making within the household.

Time allocation/recall. This method entailed identifying the amounts of time that various household members spend on livelihood activities identified in previous analysis. Emphasis was on understanding time allocation between reproduction, production,

and community activities, and how this time allocation varied within the household between genders and between different days, weeks, and seasons.

Focus Groups

In conjunction with data collection at the household level, I also gathered detailed information about the livelihood system and specific household livelihood strategies at the community level. The primary method of data collection used at the community level was focus groups (Slocum *et al.*, 1995). The partner organizations in both Amukura and Mwatate aided the identification of existing farmer groups that could be used for focus group activities. The sampling strategy for focus groups was therefore also referral sampling, as groups were selected by recommendation from the partner organization and key informants in each community. Existing farmer groups were selected on the basis that group members already knew one another and so therefore were able to interact in a familiar setting to discuss issues and get involved in the use of participatory tools.

Focus groups were only segregated by gender when gender-specific tasks were involved. Otherwise, focus groups were mixed-gender and were facilitated both by myself and my wife, so that a male and a female were present as facilitators and to ensure that gender-specific protocols were not neglected. The number of people who participated in any one focus group activity ranged between 8 and 20. Thus, groups were large enough to provide enough people with diverse interests and activities, while also being small enough so that the groups were not overcrowded to the state where data collection was very difficult.

These focus groups were used to discuss and gather data about the community livelihood system. Discussions were structured following topic guides (Appendix) and a

range of visual techniques were used to elaborate and enhance these discussions. The use of participatory visual methods was especially important for rural populations of the kind involved in this study, in which literacy of participants was not guaranteed. The intentions of using these focus groups were twofold. The first intention was to obtain a wide range of contextual information and numerical data concerning the livelihood system of the community, which could be used to supplement the data gathered at the household level. These data were then used to construct and calibrate and subsequently validate ELP models for each community, which were used to answer Research Questions 1, 3, and 4. The second intention was to openly discuss and identify attitudes towards grain amaranth in order to answer Research Question 2. All focus groups were conducted in English, but a translator was used for non-English speaking participants, in order to translate into either Kiswahili or the local language of that area, being Kiteso in Amukura and Kitaita in Mwatate.

The following participatory visual techniques were used in these focus groups:

Participatory resource mapping of the community area (Chambers, 1994a). Focus group participants used the floor or paper to map out their community land, including on the map anything and everything that they deemed important. This provided a basic understanding of the layout of the geographical area and highlighted features and specific resources of the community that were important to the people.

Seasonal calendar (Chambers, 1994a; Slocum *et al.*, 1995). Sutherland *et al*. (1999) have demonstrated the value of constructing seasonal calendars for livelihood system analysis in East Kenya. Participants were split into small groups and encouraged to construct a visual representation of the seasonal flow of livelihood system activities throughout a typical year. Groups then came together and presented to each other to discuss differences of opinion and generate an overall seasonal calendar for the community. This tool provided an understanding of the seasonal variations within the community agricultural cycle.

Gender analysis (Feldstein & Poats, 1990; Slocum *et al.*, 1995; Feldstein, 2000). This has been recently shown to be a useful research tool when used among HIV/AIDS-affected populations in Kenya by Taegtmeyer *et al*. (2006). This tool

was used by getting focus group participants to separate into two groups – one group consisting of men and the other consisting of women – and in each group, identify reproduction, production and community activities. Then, each group was asked to mark whether each activity was done by men, women or both in their community. Both groups were then brought together and presented their findings to each other, generating discussion and shared learning. Discussion centered on the identification of who does which activities and why.

Grain amaranth analysis. This tool was designed and implemented in the field in order to draw out benefits and drawbacks to grain amaranth production. Participants who had experience with cultivating grain amaranth were asked to list reasons for the production of grain amaranth, while those who had not cultivated before were asked to list reasons why they had never tried to grow grain amaranth. Both groups then came together and presented and discussed their findings. This created a culture of community learning and helped both groups of participants to understand both the pros and cons of producing grain amaranth.

HIV/AIDS analysis. This tool was designed and implemented in the field in order to understand the differences between impacts upon households due to HIV/AIDS when compared with impacts due to other sicknesses. Focus groups were asked to split into two smaller groups. One small group assessed the impacts and responses of households to HIV/AIDS, while the other group assessed the impacts and responses to malaria, a very common serious disease contracted in both study areas. Both groups presented their findings and key differences between the impacts and responses were identified.

Secondary Data Collection

Secondary data sources were also consulted to obtain constructs for the ELP modeling procedure. One of the main sources of secondary data was reports from various non-governmental organizations which are working in Amukura, including the Christian Reformed World Relief Committee and the Anglican Church of Kenya Western Region Christian Community Services. The other main source of secondary data was the Kenyan government's National Census conducted in 1999.

Ethnographic Linear Programming

The methods and tools outlined above at both the community and household levels were used to gather input data for modeling the livelihood systems of the two communities using Ethnographic Linear Programming (ELP). The input/output data

required are reflected in the table found in Appendix B. ELP is a methodology used to simulate the responses of diverse modeled households to different scenarios. It has its roots in traditional linear programming, which is a method of optimizing (maximizing or minimizing) the outcome of a primary objective subject to a set of constraints (Litow, Hildebrand & Baker, 2001). ELP builds on traditional linear programming by enhancing the dynamism of the model to better reflect reality. This is done by quantifying ethnographic data about how households are structured and operate (Peralta, 2004). Through the inclusion of ethnographic data about a modeled household, ELP introduces socio-cultural parameters into its models, including household consumption requirements, gender division of resources, and changing household compositions (Cabrera, Hildebrand & Jones, 2005). These changing characteristics of households are important to understand due to their direct impact of household livelihood security (Nyariki & Wiggins, 1997). Thus, ELP models can simulate household choices dependent upon fluctuating constraints and changing availability of resources, infrastructure or policies over periods of time.

ELP models are designed to help outsiders understand the complexity and diversity inherent in livelihood systems and in the households that are part of these systems (Hildebrand *et al.*, 2006), as well as to help households within a livelihood system understand their own resources and constraints. An ELP model is able to incorporate seasonality, an essential factor in rural livelihood systems, due to the changing nature of resources and constraints throughout a year (Chambers, 1982).

Model Construction, Calibration and Validation

Baseline ELP models to simulate the Amukura and Mwatate livelihood systems were constructed using both primary and secondary data. These ELP models were

constructed and run using Microsoft Excel® and Premium Solver®, an additional software package. Input and output coefficients for each livelihood activity were entered into the model in the Excel spreadsheet and involved the amounts of all resources required to produce one unit of an activity and the measurable output resulting from one unit of that activity. Although resource availability varied between households and over time, input and output coefficients associated with a unit of activity did not fluctuate, and this was represented in the models. The models were built to incorporate all possible livelihood strategy options available to a household within the livelihood system. When the models were run, these options were then “chosen” depending on the constraints of the modeled household.

When the initial model for a livelihood system had been developed, it was initially tested in the field with one household from that community. Rather than making assumptions in order to quickly generate a feasible model, infeasible model results were discussed with this household, in order to discover whether or not the model was realistically representing the field situation. The ELP model was subsequently revised (calibrated) multiple times until the model adequately reflected the strategy decisions made by this first household. The model was then calibrated with a second household of different composition within the same community. This process was repeated with three more households to validate the ELP model, at which point it was apparent that the ELP model simulations were as close to reality as possible. Through these iterative processes of model construction and calibration with diverse sets of households, ELP models were built for both communities that appropriately reflected each livelihood system and strategies of diverse households within these systems. A time component

was built into both models to predict changes in livelihood strategy decisions over a modeled period of years, in response to changing household circumstances, such as changing household composition.

Model Framework

Four dynamic, 11-year ethnographic linear programming (ELP) models were consequently developed through the multi-stage process outlined above. Initial data collection and model construction led to the development of the first model, entitled 'BASIC.' This BASIC model was used to simulate current livelihood strategy decisions made by each household. The other three models were developed by building in additional factors to the BASIC model. These models were used to simulate different scenarios that were facing these communities. Therefore, the four ELP models that were developed were:

1. BASIC - livelihood system without grain amaranth as a livelihood strategy option.
2. AMAR - livelihood system with grain amaranth included as a livelihood strategy option.
3. HIV+ M – livelihood system with grain amaranth included and with a male adult household member contracting HIV.
4. HIV+ F – livelihood system with grain amaranth included and with a female adult household member contracting HIV.

The model time frame of 11 years was chosen in order to model a long-enough time-period, so that when the HIV+ models were developed and run, they could simulate the impact of the three stages of HIV infection upon a household. The objective function maximized by these models was end year discretionary cash in year 11 subject to the constraints of land, labor, starting cash, food consumption requirements, and caloric and protein requirements.

Livelihood System Activities

A livelihood system is made up of the numerous bio-physical and socio-economic forces and factors that affect a community (Pomeroy *et al.*, 2002). It encompasses all possible activities reasonably available for engagement by households within that community. A household livelihood strategy is therefore one of these possible activities that a household could engage in within the framework of a livelihood system. Livelihood strategies undertaken are both household and time specific. Household livelihood strategy decisions were simulated to determine the dynamic choices of household activities over the 11-year period.

Amukura

Livelihood system activities incorporated into the BASIC ELP model were all crops and animals included in the livelihood system of Amukura. Cropping activities included in the model were: maize (*Zea mays*), beans (*Phaseolus spp.*), maize-bean intercrop, sorghum (*Sorghum bicolor*), finger millet (*Eleusine coracana*), cassava (*Manihot esculenta*), sugar cane (*Saccharum officinarum*), vegetables, green grams (*Vigna radiata*), and groundnuts (*Arachis hypogaea*). All these cropping activities were available to each household twice per year, reflecting the two rainy seasons of Amukura, except for cassava and sugar cane, which are cultivated on 18-month cycles and have no pre-determined planting seasons. Households had the option to apply no fertilizer, manure, or chemical fertilizer to any cropping activity, except for cassava. Maize and maize-bean intercrop activities also included the option of hiring oxen for plowing. Finger millet was grown by women for beer production. Animal production activities available to each household included raising cows, goats, and chickens, and selling cow's milk. The model also incorporated renting and buying land as activities, as

well as hiring male labor for any activity. The hiring of female labor is not common practice in Amukura, thus it was not included in the model. Off-farm work was only conducted sporadically by two households, and so was also not included in the model.

Mwatate

Livelihood system activities incorporated into the ELP model were all crops and animals included in the livelihood system of Mwatate. Cropping activities included in the model were: maize, beans, maize-bean intercrop, pigeon peas (*Cajanus cajan*), groundnuts, sorghum, cassava, green grams, and vegetables. All these cropping activities were available to each household twice per year reflecting the two rainy seasons in Mwatate, except for cassava and pigeon peas. Cassava could be planted in either of the rainy seasons and took 18-months to be ready for harvest. Pigeon peas were planted in the first rainy season (in the first semester, Feb-Apr) and harvested once per year at the end of the first rainy season. Pigeon peas were replanted once every two years due to declining productivity of existing plants. Households had the option to apply no fertilizer, manure, or chemical fertilizer to any cropping activity, except for cassava. Animal production activities included raising cattle, chickens, and either grain-fed or grass-fed goats, and selling cow's milk. The model also incorporated renting and buying land as activities, as well as hiring male labor for any activity. Similar to Amukura, the hiring of female labor is not common practice in Mwatate, thus it was not included in the model. Although labor requirements for crop and animal activities were considered to be the same for both Amukura and Mwatate, prices of inputs and produce for sale varied between the two communities. Also, the prices of hiring labor and renting and buying land were different between the two communities.

Model Constraints

Each year of the ELP model was divided into four parts reflecting the two rainy seasons and two dry seasons in the Amukura and Mwatate livelihood systems. The model was subject to four main sets of constraints: available land, available labor, annual cash requirements, and bi-annual consumption requirements, reflecting the two harvest periods at the end of each rainy season. Available land was initially fixed, though the model allowed households to acquire more land through renting or buying, as well as allowing them to rent out or sell their land. All other sets of constraints were variable functions of household composition. Labor constraints were separated by gender and by quarter. Age-class was calculated as follows: for each available working day, adults provided a full day of labor, youths provided 0.5 of a day of labor, and children required ($1-0.75^n$) days of labor from the female members of the household, where n is the total number of children in the household. Caring for children is estimated as a power function because when there are more children, less time is given for caring per child. Youths provided less labor than adults because approximately half of their time is spent in school. Available labor (L) per quarter separated by gender was estimated by equations (1) and (2):

$$L_m = \Sigma\, D_{pq} A_{im} \qquad (1)$$

$$L_f = \Sigma\, D_{pq} A_{if} \qquad (2)$$

where D is the number of available labor days *p* in a quarter *q*, and A is the age-class of a household member *i*, who is male *m* (1), or who is either female or a child *f* (2).

End year cash requirements were dependent upon the number of people in the household. An estimated amount of 1000 Kenyan shillings per person per year for

needs such as clothing, healthcare, and transport was built into the constraint. School fees for tuition are only required for secondary school in Kenya. These fees are the responsibility of the adult male in a household, and these were factored in dependent on the number of youths in the household. Cash requirements (C) for the end of each year separated by gender were estimated by equations (3) and (4):

$$C_m = (T*G+H*1000) \quad (3)$$

$$C_f = (H*1000) \quad (4)$$

where T is the cost of school tuition per student per year, G is the total number of youths in the household, and H is the total number of people in the household.

The consumption constraints reflect the need for a household first to satisfy its food needs before selling any consumable surplus produce. These sets of constraints were threefold, of which the first set was consumption requirements for four types of crops that all constitute an integral part of the diet – cassava, grain, legumes, and vegetables. These consumption constraints (K) were estimated by equation (5):

$$K_q = \Sigma X_j D_q A_i \quad (5)$$

where X is the necessary consumption per day for a foodstuff *j*, D is number of days in a quarter *q*, and A is the age-class of a household member *i.*

The other two sets of constraints were consumption requirements based on the necessary calories and protein required per person per year to maintain an active and healthy lifestyle. These constraints were based on the Food and Agriculture Organization's (FAO) minimum recommendations for Kenyan adults of 2250 calories per day (Gitu, 2006) and 42g of protein per day (FAO/WHO/UNU, 1985). These recommendations were adjusted for youths and children to account for their age, by a

factor of 0.75 and 0.5 respectively. FAO nutritive factors sheets provided energy and protein values for each food (FAO, 2009). Energy constraints (E) and protein constraints (P) were estimated by equations (6) and (7):

$$E_q = \Sigma\ Y^* D_q A_i \qquad (6)$$

where Y is the necessary calories per day per adult, D is number of days in a quarter *q*, and A is the age-class of a household member *i.*

$$P_q = \Sigma\ Z^*\ D_q A_i \qquad (7)$$

where Z is the necessary protein per day per adult, D is number of days in a quarter *q*, and A is the age-class of a household member *i.*

Model Scenarios

Sixteen diverse households in each community were selected through referral sampling and were then modeled under four different scenarios simulated by the four different ELP models. Cabrera *et al.* (2005) have demonstrated the importance of considering household composition when modeling households' livelihood strategy decisions. The use of referral sampling in this research enabled the selection of households with diverse compositions to be simulated for their livelihood strategy decisions using each of the four models. The emphasis here is to draw from the differential livelihood strategy options chosen by diverse households and from the differential responses of households to alternatives being tested, rather than extrapolating from what would be an average response of all households. The reason for this is because the average household has more resources than many, if not most households in a community. Therefore, only addressing the average response can

easily lead to inaccurate estimations of livelihood strategies for many of the diverse households in a community.

In this sense, using ELP models takes a grounded theory approach, in that ELP works with practical field data to build a theory of decision-making by diverse households (Pidgeon & Henwood, 2004). In this study, the key focus was on using ELP to build a theory of which kinds of households have the potential to adopt grain amaranth as a livelihood strategy, and how HIV infection of adult household members affects this potential adoption of grain amaranth. The different model scenarios thus build on each other in order to generate a detailed picture of differential household responses to grain amaranth in the context of HIV/AIDS.

BASIC model

In order to reflect the dynamism of household composition that is witnessed in real life situations, household composition changes for every household were entered at the start of years 5 and 8. Under infeasible model outcomes when all constraints could not be met, the ELP was adapted to account for the two common household strategies in Amukura in response to stress. The first of these was to reduce the end year cash requirements by removing school fee payments. A household's typical first response to stress is to remove first the female youths and then the male youths from school, in order to have cash available for necessary livelihood activities. The second adaptation to the model was to reduce basic household food consumption. This reflects another common household response when a household is unable to meet the consumption requirements of its members, and may take the form of household members skipping meals, eating smaller portions, or even eating less preferred foods (Bukusuba *et al.*,

2007). The model was simulated by reducing consumption and calorie/protein requirements in increments of 10% until the model was feasible.

For each household beginning cash was estimated to be no more than 1500Kshs[1]. The model was then simulated for every household with minimum necessary beginning cash as the objective function. This made sure that surplus cash was not carried forward through the model simulations. However, as these minimum amounts of necessary cash may not have been accurate estimations of the amount of cash each household had at its disposal, the first year results of each model were not necessarily representative. Therefore, the results from this year are not reported (Thangata *et al.*, 2007). Also, due to end-of-planning-horizon effects, the dynamic model ignored certain activities in the final year of the simulation as the model recognized that it had no long term future. Therefore, the results of the final year were also not typically representative, and so are not reported. To reflect these characteristics of the model, only results from years two through ten are reported.

AMAR model

The AMAR model was constructed as an extension of the BASIC model. All livelihood strategy options remained the same as in the BASIC model, except that this AMAR model included the additional livelihood strategy option of grain amaranth production, both for household consumption and for cash sale. Primary data gathered from the field were used as input/output coefficients for the addition of the grain amaranth option in the ELP model. This new model was then run for each of the 16 households in both Amukura and Mwatate to conduct an ex ante analysis of the

[1] The exchange rate in 2007-2008 was approximately 60 Kenyan shillings to 1 US dollar.

potential for grain amaranth adoption by diverse households in each community. This analysis incorporated only sole cropped grain amaranth production, and not intercropping systems incorporating grain amaranth, as grain amaranth was typically sole cropped in both communities.

HIV+ models

The progression of HIV in an individual can be viewed epidemiologically in three main phases – initial, asymptomatic, and final. This concept of HIV progression was incorporated into ELP modeling approaches to simulate the impact of HIV infection of an adult household member. Two HIV+ models for each community were constructed using the AMAR model as the framework and incorporating HIV infection as a dynamic event that has different impacts over time. This AMAR model was adjusted to simulate 1) for an adult male contracting HIV and 2) for an adult female contracting HIV. HIV infection was modeled to occur in year 3, with death of the HIV+ individual at the end of year 9. Year 3 of the model was considered to be the initial phase of HIV infection, years 4-8 considered to be the asymptomatic phase of infection, with year 9 being the final phase resulting in death. In order to prevent the model from adjusting and preparing for the impact of HIV beginning in year 3, the model simulations for the HIV+ scenarios were begun in year 3. These simulations were started using the results from the AMAR simulations for the start of year 3. This therefore simulated the usual real world situation of HIV infection as an unanticipated shock to a household, which had previously been making decisions based on a healthy household and yet was now forced to adjust its decision-making in response to the impact of HIV.

These two models incorporated two of the main impacts that occur as a result of HIV infection of a household member – adjustments to available labor, and adjustments

to consumption and calorie/protein requirements. In the HIV+ adult male scenario, an infected adult male was unavailable for work in both the initial and final stage of HIV infection. During the asymptomatic phase, the infected male reduced his labor contribution by an estimated 10%. Adult female labor was also reduced in this scenario in the initial and final stage to reflect labor diverted to care-giving activities for the infected male (Table 3-1). In the HIV+ female scenario, an infected adult female still provided an estimated 30% of her normal available labor in the initial stage, and 20% of her normal available labor in the final stage of infection (Table 3-2). Care-giving duties in this scenario would rest with a female youth in the household, as males do not typically contribute labor to care-giving tasks in the household, therefore female youth available labor is also reduced in this scenario (Table 3-2).

Table 3-1. Percentage reduction in available labor under the HIV+ male scenario

Phase of infection	Reduction in adult male labor (%)	Reduction in adult female labor (%)
Initial	100	5
Asymptomatic	10	0
Final	100	20

Table 3-2. Percentage reduction in available labor under the HIV+ female scenario

Phase of infection	Reduction in adult female labor (%)	Reduction in female youth labor (%)
Initial	70	5
Asymptomatic	10	0
Final	80	10

In both scenarios, the HIV+ adult was estimated to increase consumption and calorie/protein requirements between years 3 and 9. These increases were estimated at the WHO's recommended 10% level, except for years 4 and 9 (Table 3-3). In year 4, it was estimated that an adult would need an increase in consumption and calorie/protein

requirements of 25% in order to recover from the effects of the initial phase of infection. In year 9, a similar increase was estimated in order for the adult to maintain as decent a quality of life as possible in the final stage. This follows from the suggestions of the de Waal and Tumushabe (2003) report of greater required increases in consumption for HIV+ individuals than the WHO (2003) report indicated. The ELP models were then run for the 16 households in each community to simulate the impact of HIV/AIDS infection of an adult household member upon potential adoption of grain amaranth by these households.

Table 3-3. Adjustments to consumption and calorie/protein requirements under HIV+ scenarios

Phase of infection	Year	Required increase in HIV+ individual's food consumption and calorie/protein intake (%)
Initial	3	10
Asymptomatic	4 (Recovery)	25
	5	10
	6	10
	7	10
	8	10
Final	9	25

Research Validity

Validity of research refers to the closeness of the research findings to reality (Chambers, 1997). Research studies aim to maximize both internal and external validity. However, maximizing both types of validity often becomes a balancing procedure, as strengthening one type can lead to the weakening of the other.

Internal Validity

Internal validity refers to the ability of the research to establish causal linkages (Yin, 2003). Although ensuring internal validity is a common problem for experimental research, it is also necessary to consider it in social science research. When

appropriately structured, case-study designs are typically high in internal validity (De Vaus, 2001). However, there were still many potential threats to internal validity in this research study, which needed to be identified and addressed. The most serious threat to internal validity in this case study design was history. Research participants already had certain attitudes towards researchers from outside of their province and towards white researchers in particular. They also had certain attitudes towards CRWRC and its partner organizations. These attitudes, positive or negative, could have influenced information supplied, hence threatening the validity of the results. Furthermore, it is possible that some research participants expected monetary or other such benefits in return for their cooperation with research. This threat was dealt with by carefully explaining to the participants the reasons for the research and how the intention of this research is for all stakeholders[2] to benefit through sharing of information and research findings.

Much of the internal validity of this study rested on the validity of the ELP model. With a properly validated model, considerable weight is lent to the conclusions drawn from model simulations. The validation of the model rested primarily on acquiring accurate data to input into the model. The main method of ensuring that accurate data were acquired was triangulation. Triangulation refers to the use of multiple sources of data and the use of multiple methodologies. Individuals and groups were interviewed, and multiple participatory methodologies used. In a focus group setting, when someone said something inaccurate, which occurred occasionally, other group members

[2] The stakeholders in this study are threefold: the researcher and the University of Florida; CRWRC and its partner organizations; the rural Kenyan communities and limited-resource households in which the study is conducted.

corrected the information supplied. Data gathered at the household level was cross-checked with other households. The key to ELP model calibration and validation was in the initial stage when modeling with the first few households selected. Instead of including assumptions to achieve a working model, infeasible models were taken back to the households and discussed to understand what data were inaccurate in the model. Therefore, when the model had been calibrated and validated effectively, ex ante analysis to answer Research Questions 3 and 4 was as close to reality as possible.

The internal validity of this study was also enhanced through comparing observations and data collected to current literature on rural Kenyan livelihood systems. This served as a check to ensure that data gathered were appropriate. The data gathered were also more likely to be accurate because all participants were assured of anonymity. This opened the space for participants to be freer in their responses and information supplied. Furthermore, the use of participatory approaches, including semi-structured interviews, focus groups, and various Participatory Rural Appraisal (PRA) tools, enabled participants to be more open and supply more reliable information than if non-participatory approaches had been used. Finally, internal validity was enhanced as much as possible through standardization of procedures. All interviews and focus groups were facilitated by the primary researcher of this study, which ensured consistency of data collection. However, differences in approach between the two partner organizations – Western Region CCS in Amukura and Pwani CCS in Mwatate – undermined the internal validity of this study. The Community Development Facilitator (CDF) for Amukura was directly involved in the majority of focus groups conducted, whereas due to time constraints the CDF for Mwatate was only involved in the setting-

up of the focus groups, and not in how the focus groups were conducted. Focus groups in Mwatate were therefore conducted with the assistance of a local translator who was not trained in agricultural development. This most likely resulted in a learning environment in Mwatate focus groups that was less rich than that facilitated in Amukura focus groups.

External Validity

External validity refers to the ability to generalize research findings to other populations, settings, and times (Ferguson, 2004). Studies seek high external validity in order to both generalize to (from the sample to the represented population) and generalize across (from the sample to populations, settings, and times not represented by the sample) populations (Lucas, 2003).

In order to be able to generalize research findings to the other households in the community, random sampling of rural, limited-resource households would have been the best methodology to select participants. However, random sampling may not have included an adequate range of diverse households, and furthermore, random sampling was not possible as there was no sampling frame available from which participants could be selected. The main constraint to constructing such a sampling frame was time. Instead, purposive or referral sampling was used. This sampling methodology was used to identify a diverse set of households (in terms of composition) to be modeled using ELP. By obtaining this diverse set of households, population external validity was enhanced, as research findings could then be generalized from these households to other rural, resource-limited households in the community or other communities with similar livelihood systems. Sixteen households were chosen in each community to generate sufficient diversity to assess while also considering available time and funding

constraints of the researcher. Furthermore, any additional increase in sample size beyond sixteen households in each community would have unlikely generated a proportional increase in diversity of households.

The ability of this study's findings to be generalized to other communities in rural Kenya rested on the issue of representativeness, i.e. how representative these two communities are of other communities in rural Kenya in which CRWRC and its partners are promoting grain amaranth. It is likely that in other rural communities, production coefficients for an ELP model would have been similar due to similar modes of agricultural production. It is probable that research findings from this study can be generalized to communities in which the general livelihood systems are similar. Many Kenyan rural livelihood systems are based on the cultivation of cassava, grains and legumes for food, with different cash crops for export. These communities are no different. The strength of this type of external validity is thus heavily dependent on comparability of communities with the communities of study.

CHAPTER 4
THE LIVELIHOOD SYSTEMS OF AMUKURA AND MWATATE

Introduction

In order to understand patterns of potential adoption of grain amaranth in Amukura and Mwatate, it is first important to understand the livelihood systems of these communities. This chapter addresses Research Question 1 which states:

- RQ1: What are the current livelihood systems of the two communities (Amukura and Mwatate) and the current livelihood strategies adopted by diverse households within these communities?

This research question thus falls into two parts which are addressed in turn. The first part involves outlining the current livelihood systems of the studied communities. Thus, the first section of this chapter provides a description of the study areas followed by an in-depth description of the livelihood systems. The second part of Research Question 1 involves examining the range of livelihood strategies adopted by a diverse set of households in each community. Therefore, the second section of this chapter uses Ethnographic Linear Programming (ELP) to model the livelihood decisions made by these diverse households. Analysis focuses on the similarities and differences between these diverse households both within each community and between the two communities.

Study Areas

Teso District

Teso District is located in Western Kenya, on the border with Uganda (Figure 4-1). The population of Teso District is primarily made up of the Iteso people, though people from other groups also live in Teso. The Iteso are found not only in Kenya but also in Eastern Uganda. The largest urban area in Teso District is the town of Malaba, a border town

and busy entry port into Uganda. Much of Teso District, however, is rural, with small villages and large areas of land used for both crop and livestock production.

The study area in southern Teso district was Amukura Division. Basic data of Amukura Division is given in Table 4-1. Amukura is a small, densely populated, rural division in which virtually all land is used for agriculture, except for a few small trading centers and some rocky outcrops that are unfit for agricultural production. The majority of people in Amukura have no employment other than their work on their household farms. Farm sizes are typically small, ranging from 2 to 10 acres in total. The incidence of poverty is high, with an estimated 50% of the population below the poverty line (CBS, 2006).

Table 4-1. Amukura Division, Teso District – Basic Data (from ROK, 2001)

Characteristic	Value
Total area	155 km^2
Agricultural area	150 km^2
Population	53145
Population density	342.9 persons per km^2
Number of households	8958
Average number of people per household	5.9
Average land area per household	1.73 ha or 4.27 acres

Amukura Division lies at a latitude of 0.57°N at an altitude ranging between 1200 and 1500 meters above sea level. The climate in Amukura is tropical, with a mean annual maximum temperature of 28°C. The rainfall pattern is bimodal with a long rainy season running from late February/early March to June/July, and a shorter rainy season running from August to November. However, the short dry period around July does not always occur. The most reliable dry period is between December and mid-February.

Mean annual rainfall totals are usually within the range of 1000-15000mm, although rainfall patterns are highly erratic and unpredictable from season to season.

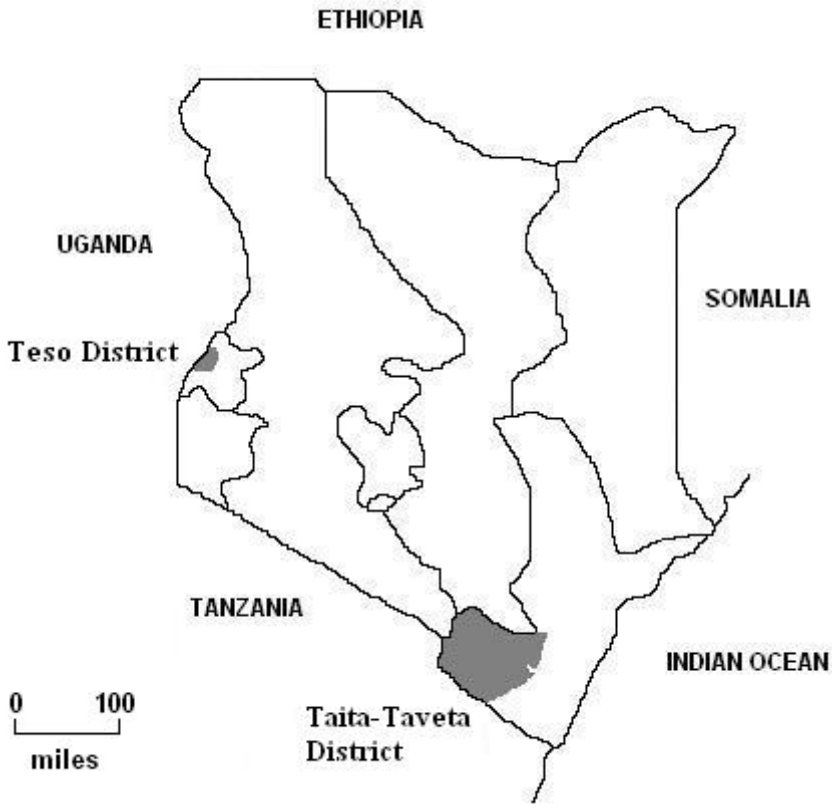

Figure 4-1. The location of Teso and Taita-Taveta Districts in Kenya

Taita-Taveta District

Taita-Taveta District is located in the south-east of Kenya in the Coast Province (Figure 4-1). It is approximately 3 hours drive inland from Mombasa, Kenya's second largest city. Taita-Taveta borders Tanzania to the south, and is sandwiched between Tsavo East and Tsavo West National Parks. There is a high incidence of wildlife in the district, though it is off the main tourist routes in Kenya. Much of the district is low in elevation and is semi-arid scrubland. The population in these dry areas is low in comparison to the upland areas known as the Taita hills. Rising some 1500-2000m

above sea level and several hundred meters above the semi-arid plains below, the Taita hills provide a cooler and more fertile environment for crop production.

The study area in eastern Taita was Mwatate Division, a large predominantly rural division, located at the base of the Taita hills on the semi-arid plains. Basic data of Mwatate Division are given in Table 4-2. Although the population of Mwatate Division is similar to that of Amukura Division, Mwatate Division is approximately 10 times less densely populated. Households in Mwatate on average are at least one person smaller than households in Amukura. However, similar to Amukura, the incidence of poverty in Mwatate is high, with an estimated 59% of the population below the poverty line (CBS, 2006).

The agricultural area of Mwatate Division is also approximately 10 times the size of that of Amukura Division. However, average farm size of rural, resource-poor farmers is still small, around 5 acres per household. Much of the agricultural area of Mwatate Division is taken up by a vast, European-owned sisal estate. Much of the rest of the area that is classified as agricultural is public access land, and is not fit for crop production, but is only typically used as communal grazing land for cattle and goats.

Mwatate Division lies at a latitude of 3.5°S at an altitude ranging between 700 and 1000 meters above sea level. As most of Mwatate Division is at a lower elevation than Amukura Division, Mwatate is subject to hotter temperatures in the dry season (December-February) which coincides with the Southern Hemisphere summer. Overall, the climate of Mwatate has noticeably cooler and hotter seasons combined with the usual tropical wet/dry season regime. Mwatate has a mean maximum temperature ranging between 31°C in January and 25°C in July. The rainfall pattern is bimodal with a

long rainy season running from March to early June, and a shorter rainy season running from late September/ early October to early December. Mean annual rainfall totals are usually within the range of 600-1000mm, although rainfall patterns are highly erratic and unpredictable from season to season.

Table 4-2. Mwatate Division, Taita-Taveta District – Basic Data (from ROK, 2001)

Characteristic	Value
Total area	1766 km^2
Agricultural area	1448 km^2
Population	58003
Population density	32.8 persons per km^2
Number of households	12250
Average number of people per household	4.7
Average land area per household	2.00 ha or 4.94 acres

The Livelihood Systems of Amukura and Mwatate

The livelihood systems of Amukura and Mwatate Divisions revolve around the agricultural cycle as the majority of people in these districts make their livelihoods through subsistence agriculture. The livelihood systems of these divisions exhibit some similarities as well as multiple differences. One of the fundamental similarities is the agricultural cycle that is based on a bimodal rainfall pattern, which encourages the production of two harvests of annual crops in a given year. These livelihood systems are also similar in consisting of both annual crop production and animal husbandry, though the crops and animals in the systems differ in many respects. The differences between the two livelihood systems are more profound than the similarities, however, and the following detailed description of each livelihood system in turn will demonstrate this.

Amukura

The Iteso who inhabit Amukura are a Nilotic plains people whose livelihood in the past revolved around cattle. However, increasing population has brought pressure to the land resource base, bringing decreasing land parcel sizes available to households. Together with this, cattle diseases, especially trypanosomiasis brought by tsetse flies, have significantly reduced herd numbers. The last major outbreak of trypanosomiasis was in 1996, which reduced stocking numbers by more than half among the Iteso.

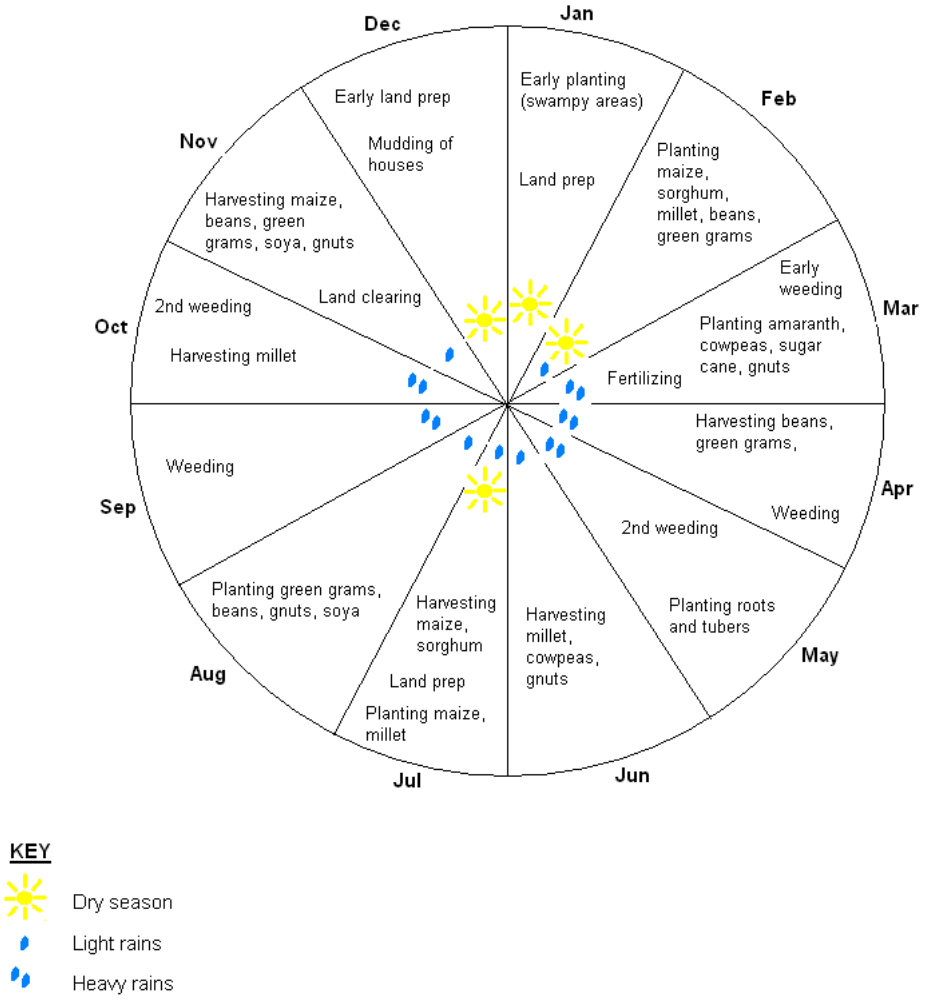

Figure 4-2. Seasonal calendar of activities for households in Amukura Division

These factors have forced the Iteso to look increasingly to crop production as a means to meet subsistence requirements, especially while they attempt to restock their cattle numbers. However, some households are no longer aggressively seeking to restock due to the decreasing availability of land, which has also led Iteso to rethink their livelihood strategies. Cropping activities have become more favorable due to the climate of Teso district which permits the cultivation of a wide range of foodstuffs for both household consumption and market sale.

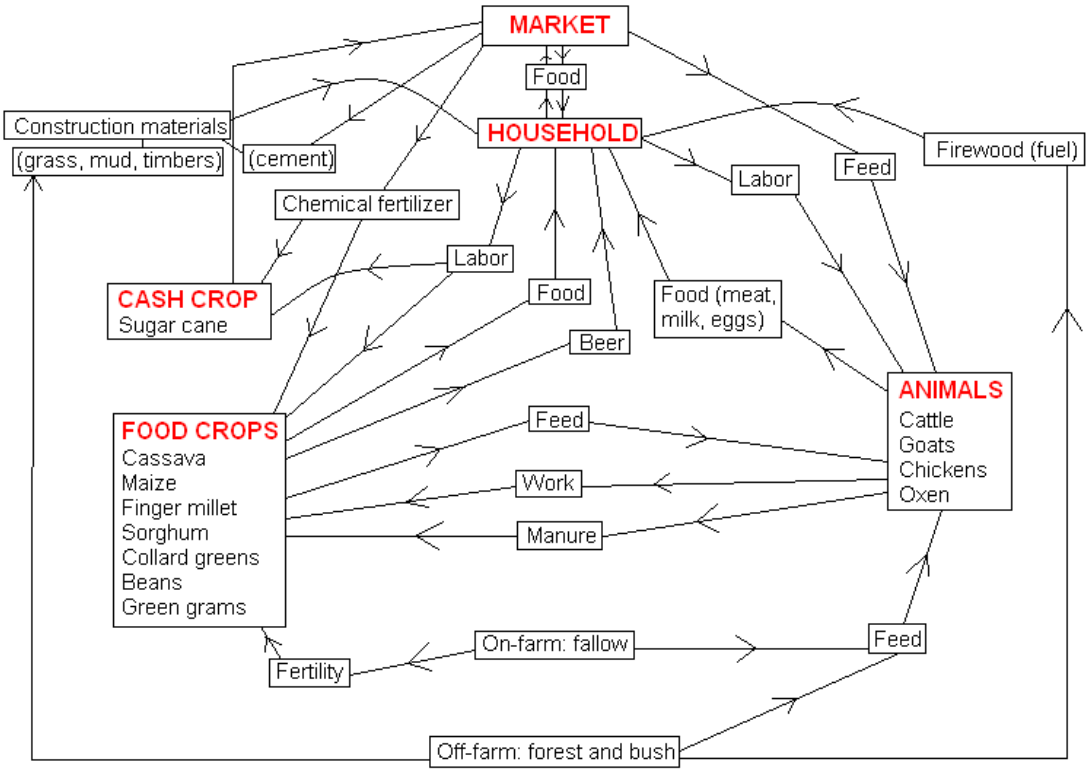

Figure 4-3. Schematic representing livelihood system of Amukura Division

The agricultural activities and livelihood system of Amukura are displayed in the seasonal calendar (Figure 4-2) and schematic diagram (Figure 4-3). Figure 4-2 describes the annual cycle of agricultural activities, whereas Figure 4-3 provides a broader picture of all livelihood system activities, highlighting the interconnectedness of

the multiple activities carried out by households in Amukura. An understanding of the livelihood system is necessary before analyzing the potential for households in this system to adopt grain amaranth as a livelihood strategy.

Crop production

The present-day Amukura livelihood system is based upon cassava cultivation as the traditional staple. Cassava (*Manihot esculenta*) is planted at any time of the year when there is at least some rain to help establish the cuttings. Cassava is propagated vegetatively using a 12-18 inch cutting that is placed either horizontally or at a slight angle in furrows at a spacing of 12-18 inches between cuttings and then covered with soil. Cassava can be harvested at any point between 6 and 24 months after planting, and is therefore harvested when needed for consumption or when a household believes a favorable market price can be fetched. Cassava is not simply a “famine crop” to fill the hungry gap when maize or other grains are in short supply, but is the crop of choice for the Iteso. It is commonly used as the main or sole ingredient of ugali – bread made from boiled flour of any starch. It is rare for an Iteso household to go without ugali for even one day throughout the year. Even if nothing else is eaten for the main meal (supper), ugali typically is consumed. There are many varieties of cassava being cultivated by the Iteso and these varieties on the whole tolerate the poorer soils of Amukura, and can be reliably depended upon for producing a harvest. However, many varieties are local and have little resistance to the devastating effects of Cassava Mosaic Virus (CMV). However, the Kenyan Agricultural Research Institute (KARI) in nearby Kakamega is now multiplying varieties of cassava that are resistant to CMV. These varieties were developed in collaboration with the National Crops Resources Research Institute of Uganda, and plans are in place to release these varieties throughout Western Kenya.

Cassava can therefore not be completely relied upon to provide a large enough harvest for households in Amukura. Furthermore, as cassava has a low nutritional value, it cannot supply all household nutritional requirements. These households therefore do not solely depend on cassava, but instead have adopted a diverse cropping strategy that encompasses the cultivation of a variety of grains, legumes and other vegetables and fruits. This diversification is not only to meet household consumption and nutritional requirements but also to have a wide range of possible entry points into the local and regional agricultural produce markets.

The second most important crop in the Amukura system is maize (*Zea mays*). This crop is cultivated twice a year during the two rainy seasons. Maize is planted in late February at the start of the long rains and usually harvested in late June or early July, when there has hopefully been a short break in the rains to allow the ears to dry on the plants. The second season crop follows quickly and is planted just weeks after the first season crop is harvested. This crop then grows through the short rains and is harvested in late November.

Some maize is harvested early and sold as “green maize”. This maize is usually roasted as a snack which fetches a good price of 5-7Kshs per ear in any trading center. However, the majority of the maize harvest is used to make ugali – once the ears are harvested, they are shucked and shelled and the grains dried in the sun on a mat. Once the grains have dried over a couple of days, they are bagged and taken to a posho mill where at a cost of 3Kshs per kg, the maize is ground into flour. This flour can then be used to make not only ugali but also a variety of other foods including mandazis, chapattis, and porridge. Maize is usually not the only ingredient in any of these food

items, but is normally mixed with other grains. In fact, to make chapattis, households buy and use wheat flour as the main ingredient. For porridge, finger millet or sorghum is usually the major ingredient.

Maize is not only sole cropped but is also frequently intercropped with either bush beans (*Phaseolus vulgaris*) or cassava. By intercropping with beans, farmers are able to save labor time on activities such as fertilizing and weeding. In addition, the beans fix nitrogen from the air into the soil which helps to counteract the heavy nitrogen demands that maize places on the soil resource. In this intercropping scenario, beans and maize are planted at the same time so that the beans can make use of the sunlight before the maize becomes tall and blocks it out. However, when intercropping with cassava, maize is planted first and allowed to grow to almost full height before cassava is planted as a relay crop to follow the maize. Although maize is a heavy feeder of nutrients, cassava is well placed to survive in the nutrient-poor soils that remain.

The other major grain crops produced in Amukura are sorghum (*Sorghum bicolor*) and finger millet (*Eleusine coracana*). Sorghum tends to be cultivated only in the long rainy season, whilst finger millet is often cultivated in both rainy seasons. In general, both crops are of lesser importance than the staples of cassava and maize, although finger millet is more widely cultivated than sorghum. This is most likely due to two reasons. First, finger millet tends to be used more frequently in traditional foods. Both crops are milled to make flour which is then mixed with other types of flour to make ugali and porridge – but finger millet is used more frequently than sorghum. Finger millet is also one of the two main crops used (the other is cassava) when making local beer. Secondly, finger millet is more suited to the climate of Amukura than sorghum. Sorghum

is more drought tolerant than finger millet and is therefore more suited to drier climates than that of Amukura (NAS, 1996).

When planting finger millet, the seeds are usually broadcast. This is because the seeds are tiny and therefore easier to broadcast than plant in rows – broadcasting is thus done to save labor time at planting. However, this causes problems when wanting to weed efficiently and effectively, as there are no easy rows for a farmer to follow along with a *jembe*. This often means that weeding is neglected or at least of low priority, resulting in lower yields than finger millet could potentially produce. Sorghum, on the other hand, is often planted in rows rather than using the broadcast method. This is because sorghum seeds are significantly larger than finger millet seeds, making it easier for farmers to work with the seeds. This allows weeding to be accomplished more easily in sorghum crops, though weeding in sorghum is also usually a low priority compared with our activities.

Legumes are very important to the Amukura livelihood system for multiple reasons. First, they fix nitrogen from the air into the soil, and so are useful as either an intercrop with a grain crop or as part of a crop rotation, so that soil nutrient levels are not as severely depleted by continuous cropping cycles of grain. Secondly, legumes are an essential part of the diet of the Iteso, and are a common supplement to ugali in a typical meal. Thirdly, the bimodal rainfall pattern is ideal for growing two crops of legumes in a year which provides a constant supply of legumes into the diet. Fourthly, legumes can fetch a good market price when there is surplus. The most common legumes grown in Amukura are green grams (*Vigna radiata*) and beans. Other legumes that are also

grown include soybeans (*Glycine max*) , groundnuts (*Arachis hypogea*) and cowpeas (*Vigna unguiculata*).

Garden crops such as collard greens (*Brassica oleracea*), tomatoes (*Solanum lycopersicum*), and onions (*Allium cepa*) are also very often found in Amukura. Collard greens are cultivated for their leaves, which are boiled in water and accompany many meals as the traditional side dish "*sukumawiki*". Tomatoes and onions are used to cook with and are often served with meals as sauce to go with ugali and enhance its flavor.

The only crop of note that is grown almost exclusively for cash is sugar cane (*Saccharum officinarum*). Although sugar cane is sometimes chewed upon as a snack, especially by those harvesting the cane in the field, the majority of the crop is grown for sale. Sugar cane production is controlled and managed by the Mumias Sugar Company, which operates from a neighboring district. Households who choose to cultivate sugar cane adhere to certain protocols directed by the company. These households usually sign a contract with the company that guarantees that the company will purchase the sugar cane at a certain price from the household at the time of harvest.

Sugar cane cultivation requires substantial inputs in terms of labor, land and cash. Labor requirements are high because sugar cane takes a lot of time to plant, weed, fertilize and harvest. In order to get high yields, a sugar cane crop must be weeded at least 3-4 times. In addition, harvesting is so laborious that households have to hire labor from the sugar cane company to assist with the harvest. The company also gives out strict guidelines about fertilizer application in order to get high yields, and the application of these by hand is very time-consuming. Sugar cane takes approximately 18 months

before it is ready to be harvested. Therefore, whatever land is put into sugar cane production is not able to be utilized for any other activity for at least 18 months. This requires considerable planning by a household, and it is usually only households with access to larger land areas that are able to enter into sugar cane production. Sugar cane also requires significant cash investment for chemical fertilizers, hired labor, and transport of the product to the company's processing plant. Households therefore must wait at least 18 months or more before they see any return on this crop. However, if harvests are good, households that can afford to plant sugar cane are able to get a decent return on their investment.

Two other cash crops used to be of major importance in Amukura. There is still an old cotton ginnery within Amukura Division but this has been out of operation for several years. Cotton (*Gossypium* spp.) used to be a lucrative cash crop until the 1990s when the world price of cotton plummeted. This resulted in a large scale abandonment of cotton as a livelihood strategy option in Amukura. The other cash crop that used to be lucrative is tobacco (*Nicotiana tabacum*). Although some tobacco is still grown in the area, and British-American Tobacco still have an office in Amukura, tobacco cultivation is on the decline. This is also due to declining world prices linked with increasing worldwide awareness of the health problems caused by tobacco smoking.

Animal production

Since the late 1990s, the Iteso have gradually been restocking their cattle herds following a trypanosomiasis outbreak. However, cattle stocks are not at the levels they once were and increasingly households are turning towards keeping smaller animals due to increasing land pressure. Cattle require a much larger area of land than animals such as goats and chickens, and households are finding it difficult to set aside enough

pasture land to keep several cows. Furthermore, in order to keep cattle from further disease outbreaks, the Ministry of Agriculture is strongly promoting that cattle be taken to dips or sprayed every 2-3 weeks. This is proving costly for many households.

Goats and chickens are kept by households generally in small numbers. Chickens are free range and left to find any food they can in and around the compound. They are usually kept inside the homestead at night to protect from predators. Goats are tethered and allowed to graze either on public land or on fallow land owned by the household. In comparison, cattle are usually tethered if a household owns only a few cows, or they are herded by male youths to search for public pasture in the case of larger herds.

All animals are kept for their meat production. Cows are also kept for milk production, for which there is a good local market. A few households also keep oxen, which are used primarily for plowing work in the *shambas*. Those households that own oxen will frequently rent them out to other households in the area at a flat rate of 300Kshs per day. There is high demand and constant usage of oxen for this purpose throughout Amukura.

Mwatate

The Taita who inhabit Mwatate are a Bantu people who practice mixed agriculture. Mwatate Division encompasses much of the lower elevation parts of Taita District and has a much sparser population density than that of Wundanyi Division which encompasses the higher elevations of the Taita hills. The Taita people settled in this region as a place of refuge from continual raids by the neighboring Maasai. In practicing mixed agriculture, the Taita cultivate a variety of crops as well as raising different animals.

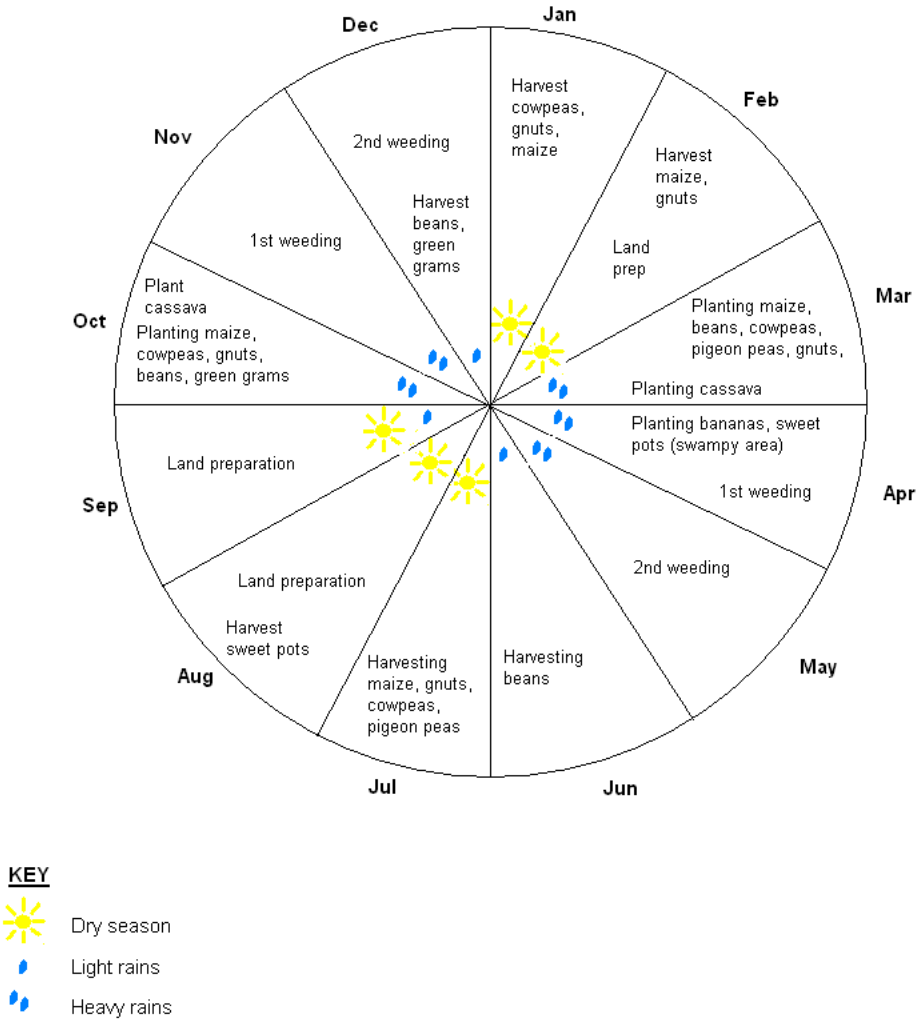

Figure 4-4. Seasonal calendar of activities for households in Mwatate Division

The Mwatate livelihood system revolves around the annual cycle of two rainy and two dry seasons (Figure 4-4). Annual cropping takes place during the rainy seasons, allowing two crops per year to be cultivated if rains are sufficient. The organization of the livelihood system of Mwatate is shown in the schematic diagram (Figure 4-5). The general structure of the Mwatate system is similar to that of Amukura. However, there are significant differences between the two systems, most notably in the cropping and livestock activities that predominate.

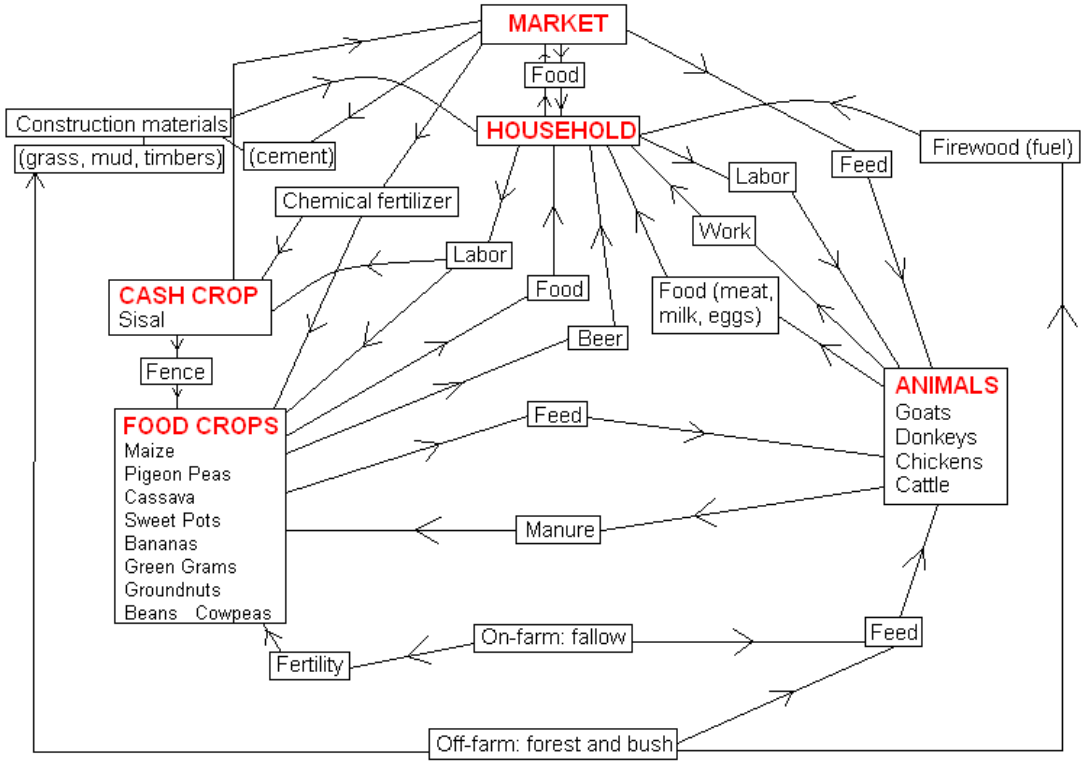

Figure 4-5. Schematic representing livelihood system of Mwatate Division

Crop production

The Mwatate livelihood system is dominated by the production of maize. Although much of the area receives less mean annual rainfall than Amukura Division, maize is emphasized more in Mwatate. Maize is grown widely as it is the traditional food of the Taita people. It is eaten everyday by the majority of households as ugali. It is also used as an ingredient for making porridge and local beer.

Maize is planted twice a year, once in March and once in October, with harvesting in July and February. This coincides with the bimodal rainfall pattern that is more distinct in Mwatate than Amukura. However, rainfall is very unpredictable and unreliable in Mwatate Division and rainfall totals can vary significantly from season to season. It is

virtually impossible to know when a rainy season is going to be drier than usual, which makes maize cultivation in Mwatate a risky venture. The only area in the division that can be relied upon to produce fair yields even in dry years is a low-lying swampy area next to a seasonal river.

Pigeon peas[1] (*Cajanus cajan*) are the main supplement to maize in the diets of households in Mwatate. These are the most common legume and are well adapted to the semi-arid climate of Mwatate. Pigeon peas are cultivated as a two-year perennial crop. This reduces the need to plant new seeds from once a year to once every other year. This also allows established plants to continue to fix atmospheric nitrogen even after the peas are harvested the first year.

Pigeon peas are planted at the beginning of the long rains, in March. They are harvested in July, but the plants are kept in the ground until the following July when they produce a second harvest. After this, the plants are removed and new plants are seeded the following March. The plants are pulled after two years and used as livestock feed because pigeon pea yields begin to reduce on the older plants. Also, pest and disease pressure can often start to build on these perennial crops after two years, so by pulling up the old plants and planting new ones in another area of the household farmland the following March, the cycles of pests and diseases are broken. Pigeon peas are usually boiled and eaten together with ugali to provide protein to household members.

[1] Pigeon peas (*Cajanus cajan*) are confusingly called cowpeas (*Vigna unguiculata*) (*kunde* in Kiswahili) in Taita District even though cowpeas are also grown in Taita. People distinguish between the two by referring to pigeon pea as a tall cowpea, whilst referring to cowpea as a short or vining cowpea.

Other staple crops cultivated in Mwatate include sweet potatoes (*Ipomoea batatas*), bananas (*Musa* spp.) and cassava. Cassava production is not at the same level as in Amukura. It is cultivated as a famine crop, one that is turned to in dry years when the maize crop fails. By producing cassava, households spread risk so that they are not solely reliant on maize. Cassava is very tolerant of the poor soils and erratic climate of Mwatate, and so can be relied upon in times of need.

On the other hand, production of sweet potatoes and bananas are limited to the one swampy area in Mwatate Division, just to the east of the town of Mwatate. This area is one of intensive crop production, as this is the only area that has access to water throughout the year. Many of the fields in this swampy area are irrigated using furrows which are filled during the rainy season by the seasonally flowing river that runs through the area. The land in this area is owned by a number of households and is eagerly sought after by many more. It is common to find households renting out portions of this swampy land as they can command a high rental fee for these areas.

Other legumes that are common to the Mwatate livelihood system are cowpeas, beans, groundnuts and green grams. Whereas cowpeas are found more often in the swampy area, the other three are commonly grown in more arid fields as they are more drought tolerant. These legumes are an alternative to pigeon peas in the diets of households in Mwatate. These legumes are planted twice a year around the same time as maize is planted. Beans and green grams take fewer days to mature than cowpeas and groundnuts, and so yields of the different legumes are highly dependent upon both the amount of rainfall in the season as well as the length of the rainy season.

The major crop grown for cash in Mwatate Division is sisal (*Agave sisalana*). There is an extensive private sisal estate (Teita Estate) in Mwatate Division that is owned and run by Europeans. Sisal is cultivated for its fiber but can take up to 3-4 years for this fiber to be ready for harvest. The fibers in the mature leaves of a sisal plant are harvested and used to make rope, twine, sacks, and carpets. Sisal is an ideal crop for Mwatate as it is tolerant of semi-arid conditions and can grow on poor soils. However, although sisal is common throughout Mwatate Division, it is not normally cultivated by resource-poor households. This is probably because these households are unable to compete with the nearby estate for a share of the sisal market. Instead, sisal is typically grown by households as a living fence surrounding valuable arable land. The spiky leaves of sisal plants are useful in deterring wandering livestock from entering fields. Households also occasionally harvest sisal fibers from a few plants for use in various activities, such as for rope-making and for construction.

Animal production

Most households in Mwatate Division have some animals, though animal production does not play as an important role here as it does in Amukura. Goats and chickens are the most common animals in the Mwatate system. Goats are well adapted to the dry climate and are either tethered or left to roam freely through fields and graze. Goats are seldom watched over or herded. Chickens are free range and are kept inside at night. Chickens are kept not only for meat, but more importantly for egg production. Cattle numbers are low and forage for cows is not as abundant in Mwatate as in Amukura. Milk is therefore a rarer and more expensive commodity in this district than Amukura.

The animals that are most commonly seen in Mwatate, however, are donkeys. Donkeys are virtually non-existent in Amukura, yet in Mwatate they are a fundamental part of the livelihood system. Donkeys are crucial in providing transport for households. Donkeys are used to draw carts for carrying drums to collect water, which in the dry season is only available in the swampy area of the division. Some families have to send a member of their household with a donkey cart over 5 miles one-way to collect water, essential for the daily function of the household. Donkey carts are also used to transport goods to and from local markets. Therefore, donkeys are highly utilized and prized animals in the Mwatate system. When those households that own donkeys are not using them, they typically hire out their donkeys to other households.

Gender Division of Labor

Amukura

The interviews and gender analysis participatory tool used in focus groups revealed that many activities in a typical rural household in Amukura are shared by both men and women. This has not always been the case, but as the Iteso have become more exposed to other cultures, there has been an increasing trend toward mutual cooperation and sharing of tasks. However, there are still some tasks which both men and women identify as either male- or female-specific tasks.

As for daily activities, both men and women take part in agricultural work and marketing of produce or other business ventures. Both also have time for leisure and resting, though it is likely that men have more time for this than women. This is because a large amount of the daily activities are still considered the work of women. These activities include collecting water for household use, collecting firewood, preparing, cooking and serving food, cleaning the house, and washing clothes and utensils.

Looking after young children is also considered to be a woman's role, though both men and women claim a role in educating those children who are not in school. The daily activities considered to be the work of men include looking after any livestock the household owns, maintenance of structures including the house and any fences, and keeping the household compound clean through slashing the area surrounding the family home.

In the *shamba*, men and women from the same household often work together on tasks such as land preparation, planting, weeding, thinning, and harvesting. Distinctions in gender roles can be made only on certain tasks. Site planning and site clearing are both men's tasks. Men therefore have the ultimate say in what crops are to be planted in which *shambas*. They are responsible for clearing the land so that it can be prepared either by *jembe* or with an ox-pulled plow. If oxen are used to prepare the land, this is a clearly defined male task. However, both men and women can prepare land using a *jembe*.

While a crop is growing in a *shamba*, men and women share most tasks (as mentioned above), yet men still exhibit overall control in that they are the ones who inspect and check the crops as they grow. Men are also the ones who take charge of fertilizing those crops that require fertilizer. This further highlights the control that men continue to exhibit on the overall system in deciding which crops are the ones to be fertilized. After crops are harvested, men only tend to take an active role in post-harvest processes for those crops that are to be prepared for cash sale, especially sugar cane and maize. If the crop is more likely to be utilized in household consumption, then it is typically considered a woman's crop. Therefore, crops such as sorghum, finger millet,

beans, groundnuts, and green grams are often considered to be women's crops. These crops tend to require large labor inputs through activities such as drying, threshing, and winnowing. These tasks are normally considered women's activities. When crop storage is involved, however, men and women are both involved as they prepare a suitable arrangement for the harvested material.

Mwatate

The interviews and gender analysis participatory tool used in focus groups revealed that, similar to Amukura, many activities in Mwatate are shared between men and women. There were also, however, some activities that are still structured along gender lines. Interestingly, the women in Mwatate showed a much greater awareness and depth of knowledge of all activities done, both daily and in the *shamba*. However, even if the men were aware of all activities, those that were considered female tasks frequently went unmentioned in interviews and in group work. This indicates that to a greater extent in Mwatate compared with Amukura there is a lack of appreciation by men of women's activities and workload.

Men and women share the daily workload in Mwatate when it comes to agricultural activities such as going out to the *shamba*, milking any goats or cows a household has, and conducting agricultural business. Men even help women collect water for daily household use, which does not happen in Amukura. This is because much of the water collection is done by taking a donkey cart down to the seasonal river/swamp, and filling and loading up drums of water onto the cart to take home. In contrast, water in Amukura is transported by women usually in jerry cans on their heads – a task that a man would rarely do. Except for milking, all other daily tasks that involve taking care of any animals the household has are done by men. Taking animals to pasture, tethering and herding

are all activities done by men in Mwatate. Meanwhile, similar to Amukura, a large proportion of the daily activities are done by women. These include collecting firewood, preparing, cooking and serving food, washing clothes and utensils, and taking care of children. Women have much less time than men for leisure or resting.

Activities in the *shamba* are generally shared by men and women. There is less gender division of cropping activities in Mwatate than in Amukura. From preparing the *shamba* to planting, weeding, fertilizing, and harvesting – all these activities are done by both men and women. Crops are only divided by gender post-harvest, and this relates to whether the crop is to be prepared for home consumption or is to be sold for cash. The portions of harvested crops that are set aside for home consumption enter the women's domain. The sale of crops is divided between men and women. Women are usually responsible for selling in the local markets, whereas if regional or national markets are sought for produce, men usually take control of this sphere because there is the potential for more cash to be made, and because men usually have better access to transportation opportunities to access these larger markets.

Other gender divisions of labor in the *shamba* include work done on more specialized tasks. Due to the semi-arid climate, water harvesting is essential for good crop production. The main technique used in Mwatate is the construction of V-bands or tied-ridges which create depressions in a *shamba* where water can collect to nourish crops. These V-bands are always constructed and maintained by men. Furthermore, the maintenance and care of any fruit trees that a household owns is also the task of the men in the household. Although women assist men in planting trees, it is up to the men

to take care of these trees through pruning, identifying and dealing with disease and pest problems, and harvesting fruit.

This understanding of the gendered division of labor in these livelihood systems improves our ability not only to model and simulate the systems more accurately, but also understand the context into which grain amaranth is being promoted. It is essential to appreciate which grain amaranth activities will be considered male, female, or gender-neutral in order to be more effective in modeling and, if warranted, promoting the crop.

Modeling Livelihood Strategies Decisions of Diverse Households in Amukura and Mwatate

In order to answer the second part of Research Question 1, which asks: "What…are the different livelihood strategies adopted by diverse households within these communities?" ELP models were constructed, validated and run for both livelihood systems to simulate the decision-making processes of diverse households within each community. This process was described in detail in Chapter 3. This chapter presents the livelihood systems without grain amaranth – that is, grain amaranth is not included as a livelihood strategy option in the BASIC ELP model. The results from the BASIC model runs therefore outline the diversity of strategies adopted within the livelihood system before the introduction of grain amaranth. This section presents the results from these model runs and analyzes the patterns of livelihood strategy adoption by diverse households within the two communities. Discussion focuses on both comparing household livelihood strategies adopted within each community, as well as comparing the differences in livelihood strategies adopted between communities.

This section first addresses the assumptions made when constructing the ELP models, before discussing the feasibility of the different households in each community. Following this, analysis and discussion focuses on uncovering the differences in livelihood strategies adopted, first through understanding differences in end cash scenarios, and then through an analysis of constraints upon and resources available to each household – household composition, land, labor, and minimum acceptable consumption requirements.

ELP Assumptions

The various assumptions made when constructing the BASIC ELP models for both communities were:

- There was no variation in climate across all years of the models. Therefore, yields for each crop were static and did not vary from year to year. All yields were estimated at dependable levels, meaning that these yields were what a household expected 90% of the time.
- There was no variation in prices of crops across all years of the models.
- There was no inflation in prices and costs across all years of the models.
- The amount of land that a household could rent was also capped, to reflect the scarcity of available good quality agricultural land in both communities. Rental land was available by semester and was capped at 1 acre in the first semester (February-July) and 2 acres in the second semester (August-January).
- The sale of milk and beer in both communities was capped to reflect the probable cap on demand of these items in each community. Sales of both were capped at 500 liters per household per semester.
- Hired labor was capped depending on the season. This represented the fact that hired labor was more difficult to obtain during busy seasons. Hired labor was capped at 30 total days in February-April and in August-October, at 45 total days in May-July, and at 42 total days in November-January.
- Available hired labor was male labor only and could not be used for female-specific tasks. This represented the usual situation of men being available for hired labor, and not women in both communities.
- Available female labor was assumed to be less than available male labor due to women's involvement in reproduction activities such as washing, cleaning, cooking, and collecting water and firewood. Therefore, men were estimated to provide five full days per week, and women four full days per week for production livelihood system activities. Reproduction activities were assumed to be necessary for every household, and were not included in the model.

- All end year cash was available as beginning cash in the start of the next year of the model, after deducting for school fees and other necessary and discretionary household expenses dependent upon the number of people in the household.
- Simulations started with minimum cash for model feasibility. First, the model was solved with 1000Kshs for male cash and 500Kshs for female cash in order to obtain values for the minimum cash needed to generate a feasible model. When these values had been obtained, the model was run again using the resulting minimum cash values to generate the model solutions. This resulted in different households having different amounts of beginning cash, simulating the real scenario of a diverse set of households in each community with diverse cash resources.

Diverse Households Modeled

Table 4-3. Modeled Amukura household compositions (male adult - female adult -male youth -female youth - child) and available land and cash resources

Household	Composition years 1-4	Composition years 5-7	Composition years 8-11	Land area (acres)	Starting cash in Kenyan shillings (male/female)
1	0-2-2-3-1	0-2-1-3-0	0-2-1-2-0	7	190/50
2	0-1-0-2-1	0-1-1-1-0	0-1-1-1-0	4.5	1000/280
3	0-1-1-1-3	0-1-1-2-1	0-1-1-2-0	3.5	680/130
4	0-1-0-0-2	0-1-1-0-1	0-1-1-1-0	2	1000/310
5	1-1-0-0-2	1-1-0-1-2	1-1-1-1-1	2.5	40/50
6	1-1-3-3-1	1-1-3-2-0	1-1-2-1-0	6	140/30
7	1-1-1-1-1	1-1-2-1-1	1-1-1-1-1	3.5	760/20
8	1-1-1-0-2	1-1-2-0-1	1-1-2-1-0	6	60/30
9	1-2-1-1-2	1-2-1-2-1	1-2-1-2-2	4	110/30
10	2-3-3-2-0	2-2-2-2-0	2-2-1-1-0	6.5	390/60
11	1-1-0-0-0	1-1-0-0-1	1-1-0-1-2	2.5	30/10
12	1-1-2-2-4	1-1-2-2-2	1-1-2-2-1	5.5	370/50
13	2-1-1-0-1	1-1-1-1-1	1-1-0-2-1	5.5	30/20
14	1-3-0-2-3	1-3-1-2-2	1-3-2-1-2	5	120/30
15	1-1-0-0-1	1-1-0-1-1	1-1-1-1-1	2.5	30/20
16	1-1-0-1-1	1-1-1-1-1	1-1-1-2-1	3	50/20

Sixteen households with diverse and dynamic compositions were modeled for each community (Tables 4-3 and 4-4). All households change in composition in years 5 and 8 of the 11-year model. Household compositions in year 1 reflected real households interviewed in each community. Household changes in years 5 and 8 reflected expected or possible changes over time, to simulate real world scenarios of dynamic households.

In each community, four female-headed households (FHH) were modeled[2] and 12 male-headed households (MHH). As the FHH in Amukura were recorded as household numbers 1, 2, 3 and 4, the FHH in Mwatate were also recorded as the same household numbers for the sake of standardization and to avoid confusion.

Table 4-4. Modeled Mwatate household compositions (male adult - female adult -male youth -female youth - child) and available land and cash resources

Household	Composition years 1-4	Composition years 5-7	Composition years 8-11	Land area (acres)	Starting cash in Kenyan shillings (male/female)
1	0-2-2-3-1	0-2-2-2-1	0-2-1-2-0	7.5	330/70
2	0-1-1-1-1	0-1-1-0-1	0-1-1-1-0	5	660/10
3	0-1-1-2-2	0-1-1-1-2	0-1-2-2-0	4	560/40
4	0-1-1-0-1	0-1-1-0-1	0-1-1-1-0	2	540/10
5	1-1-0-0-2	1-1-0-1-2	1-1-1-1-2	3	870/200
6	1-1-3-3-1	1-1-3-2-2	1-1-2-3-1	6	140/90
7	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	4	430/30
8	1-1-2-0-2	1-1-1-1-3	1-1-2-1-2	7	600/360
9	1-2-1-1-2	1-2-2-1-2	1-2-1-2-3	6	350/50
10	2-2-2-2-1	2-2-2-3-2	2-2-3-2-2	8	220/90
11	1-1-0-0-0	1-1-0-0-1	1-1-0-1-2	3	30/20
12	1-1-2-2-3	1-1-1-2-2	1-1-2-2-2	7	830/130
13	2-1-1-0-2	2-1-1-1-2	2-1-1-1-1	5.5	540/330
14	1-3-1-2-4	1-3-1-2-2	1-3-3-3-3	6.5	420/80
15	1-1-1-0-1	1-1-1-1-1	1-1-1-1-2	2.5	150/70
16	1-1-0-1-1	1-1-1-1-1	1-1-1-1-0	5	60/30

Household Feasibility

Before analyzing the differences in livelihood strategy adoption by diverse households, it is instructive to discuss and analyze why not all households were able to meet minimum acceptable consumption and end cash requirements in the model simulations. Such a discussion starts to create a framework for analysis of differential livelihood strategy adoption by diverse households. The two strategies commonly employed by households that were unable to meet minimum acceptable consumption

[2] A household was only considered to be FHH in the absence of an adult male.

and end cash requirements in years of difficulty were reducing household food consumption and removing youths from school. Consumption requirements for a household in either community were threefold – the need to meet certain food requirements for a balanced diet, the need for a certain number of calories, and the need for a certain amount of protein. School fees requirements were only for secondary school, and were therefore dependent on the number of youths in a household.

Amukura

Nine out of the 16 households were able to meet their consumption and end cash requirements for all 11 years of the BASIC model. However, the other seven households were unable to meet these requirements and so adopted the two common strategies of reducing household food consumption and/or removing youths from school for a period of time. During certain time periods (years 1-4, years 5-7 and years 8-11), four of these seven households had to reduce food consumption by a certain percentage of minimum requirements, one had to remove youths from school, and two had to adopt both strategies (Table 4-5).

In terms of consumption, failure to meet protein requirements was the main reason for household infeasibility. In order to meet minimum acceptable protein needs, most households ate extra calories from grains such as maize. In the case of a household being unable to produce enough maize to meet these protein demands, the household attempted to increase protein supply by incorporating sorghum and/or finger millet production for consumption as additional livelihood strategies. This was particularly the case for the FHH modeled.

For those households that were unable to meet minimum acceptable consumption requirements, reductions in protein intake were more severe than reductions in calorie

intake. Unfortunately, these households remained trapped in a vicious cycle of poverty and malnutrition which they were unable to break due to the low availability of a wide range of resources for these households. These households often could not meet protein demands due to the high amount of labor required for many legumes. While households that could meet minimum acceptable protein requirements had sufficient resources to produce groundnuts, the legume that contains the highest amount of protein by weight out of all the legumes produced in Amukura, households that could not meet these requirements often produced beans as these were cheaper to produce than groundnuts. However, beans did not provide these households with enough protein to meet their minimum acceptable protein levels. Thus, households that failed to meet minimum acceptable consumption requirements generated household members with a lack of strength and ability to work, which in turn led to a lack of ability to generate cash in order to buy food, which once again led to a lack of food.

Table 4-5. Necessary responses of Amukura households unable to meet minimum acceptable consumption and cash requirements

Household	Percentage calorie reduction			Percentage protein reduction			Number of youths removed from school		
	Years 2-4	Years 5-7	Years 8-10	Years 2-4	Years 5-7	Years 8-10	Years 2-4	Years 5-7	Years 8-10
3	24	0	0	30	10	0	1	2	0
4	0	0	0	5	0	0	0	0	0
5	1	0	0	18	0	0	0	0	0
6	0	0	0	0	0	0	3	2	1
8	26	11	0	40	30	0	0	0	0
12	28	0	0	40	10	10	2	0	0
13	10	0	0	30	10	0	0	0	0

There were also other reasons for these seven households not being able to meet consumption and cash requirements. Household 6 had more youths than it was able to afford to send to school. Household 13 was constrained by its lack of female labor,

especially in the early years of the model. Meanwhile, households 3, 4, 5, 8, and 12 all started in year 1 of the ELP with at least two children, and therefore had low Producer/Consumer ratios. This producer-consumer imbalance meant that these households did not have enough labor to meet their necessities.

Mwatate

Eight out of the 16 modeled households in Mwatate were able to meet minimum acceptable consumption and end cash requirements, but the other half were unable to meet these requirements for all years of the model (Table 4-6). Out of the eight households that did not meet requirements, six were unable to meet school fee requirements, while only two were unable to meet both school fee and consumption requirements.

Table 4-6. Necessary responses of Mwatate households unable to meet minimum acceptable consumption and cash requirements

Household	Percentage calorie reduction			Percentage protein reduction			Number of youths removed from school		
	Years 2-4	Years 5-7	Years 8-10	Years 2-4	Years 5-7	Years 8-10	Years 2-4	Years 5-7	Years 8-10
1	0	0	0	0	0	0	3	0	0
3	0	0	0	0	0	0	2	1	2
6	0	0	0	0	0	0	6	2	3
8	34	9	0	28	0	0	2	0	0
9	0	0	0	0	0	0	1	0	0
10	0	0	0	0	0	0	2	0	0
12	0	0	0	0	0	0	4	0	0
13	36	4	0	29	0	0	1	0	0

The main consumption constraint for households in Mwatate was not protein but meeting minimum acceptable calorie requirements. Households 8 and 13 were unable to meet minimum acceptable consumption requirements because they were not able to provide enough calories for their households. Both of these households were

constrained by their lack of available female labor. Neither of these households had a female youth in year 1 of the model, and with only one adult female, three males, and two children, there was not enough female labor to produce enough food to meet minimum acceptable household consumption needs. These households also lacked the cash required to send their youths to school in years 1-4 of the model.

Mwatate households did not struggle to get protein into their diets, as Amukura households did. Mwatate households had a smaller range of grain production strategies available than Amukura households, and in addition to this, Mwatate households focused more on maize production for *ugali* rather than cassava. Therefore, Mwatate households had ample protein in their diets, as their production for consumption focused more on maize and a rich variety of legumes, whereas Amukura diets focused more on cassava with grains and legumes as a supplement to the cassava. As cassava is low in protein, this resulted in low-protein diets in Amukura when compared with Mwatate.

Although household numbers 1, 3, 6, 9, 10 and 12 were all unable to meet cash requirements, the reasons for this varied among these diverse households. Households 1 and 3 were FHH and the lack of adult males in these households reduced the opportunities for these households to generate enough cash to send all their youths to school. Households 6, 10 and 12 were constrained by the large number of youths in the household, whereas household 9 was constrained by its large household size, both of which resulted in taking youths out of school for a period of time.

Household Resource and Constraint Analysis

Households modeled were diverse in terms of both composition and available resources. This led to the adoption of diverse livelihood strategies by the households

modeled in both Amukura and Mwatate. The impacts of both household composition and household availability of cash, land and labor subject to the constraints of end cash and consumption requirements are analyzed to uncover the reasons behind the adoption of diverse strategies.

Amukura

Food production/consumption

Household composition was arguably the most important factor influencing the adoption of livelihood strategies for food production. Among the 16 households modeled in Amukura, there was a significant difference between FHH and MHH in terms of the livelihood strategies adopted for food production. Although both FHH and MHH produce similar quantities of cassava and vegetables for food production, these types of household differ in their production of grains and legumes. Whereas grain production in MHH is overwhelmingly dominated by maize production, FHH produce a mix of grains for food consumption by the household. This mix includes a greater dependence upon sorghum and in the case of household 4, which is the most constrained of all FHH, dependence in part upon finger millet production. Maize production requires more adult male labor than sorghum or finger millet production. Therefore, this difference in grain production between MHH and FHH is due to the lack of adult male labor in FHH.

In terms of legume production, MHH were able to adopt a wider range of livelihood strategies as once again FHH were constrained by their lack of adult male labor. FHH thus produced almost solely groundnuts for household legume consumption, whereas all but two MHHs grew a mixture of groundnuts and beans. Household 10 was even able to produce green grams for home consumption – this household had the most adult and youth labor.

End cash

Figure 4-6 shows the accumulative end cash for each of the 16 diverse households in Amukura. There is a wide range in end cash totals of these different households, with some households making large increases in end cash while other households are struggling to make ends meet. These differences in accumulated end cash are due to households in Amukura adopting diverse livelihood strategies, which were a direct result of both differences in household compositions and available resources.

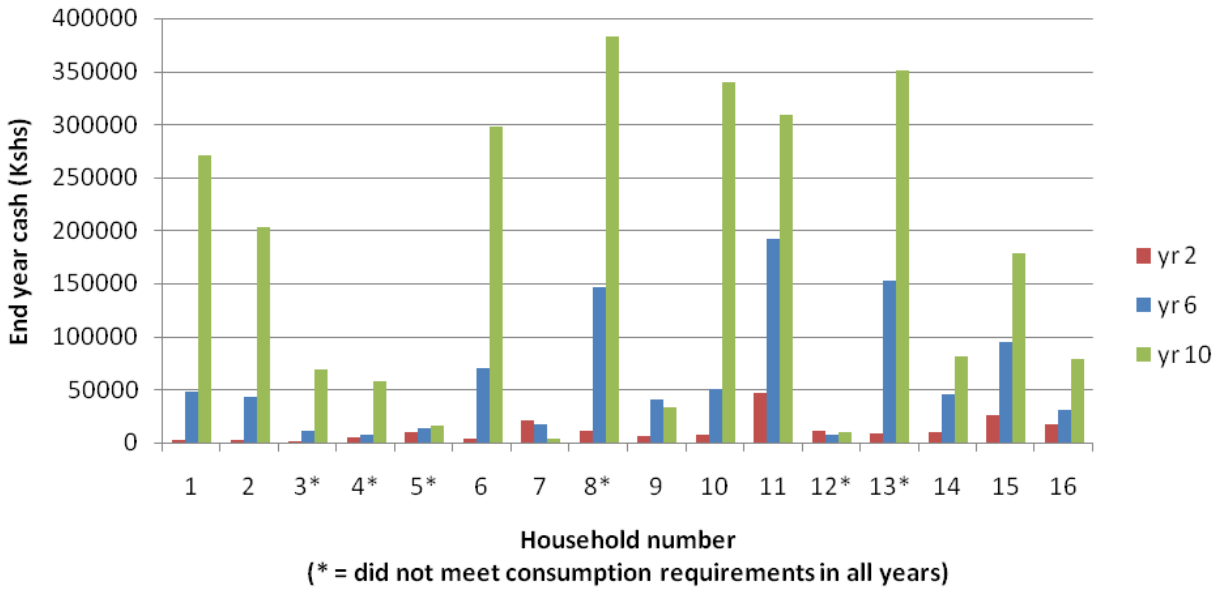

Figure 4-6. Accumulated end year cash in years 2, 6 and 10 for Amukura households

These household end cash results are directly linked to the amount of cash income obtained from different livelihood activities adopted by each household. By comparing the different relative amounts of cash income obtained from these activities (Figure 4-7), it is clear that sugar cane production is one of the main factors that impacts household end cash in this community. The eight households with the highest amount of end cash in year 10 (households 1, 2, 6, 8, 10, 11, 13, and 15) all invested heavily in

sugar cane production. This investment is closely linked with the size of land holdings of a household. With the exception of households 11 and 15 from this group, the other six households all have land holdings that are larger than average for Amukura as a whole. However, households 11 and 15 were both able to generate enough cash to each purchase an extra acre of land in years 4 and 5 of the model respectively. Therefore, these households have land to spare once they have met household demands for food production, and this extra land can be devoted solely to cash crop enterprises. Sugar cane production also requires a significant input of male labor, and the majority of these households are well supplied with male labor. As a result, therefore, even households 8 and 13, which were not able to meet consumption requirements in early years of the model, were able to generate large amounts of end cash in later years of the model as these households were both endowed with plentiful supplies of male labor and land.

Households that did not have the necessary resources to enter into sugar cane production adopted different livelihood strategies to meet end cash requirements. Households 9 and 14 produce little to no sugar cane, yet were still able to meet requirements through a high production of both grains and legumes for sale (Figure 4-7). These households were the two polygamous households that were modeled, indicating that, when there is an abundance of female labor, cash requirements are most often met by selling surplus of traditional food crops, which are in the female domain.

Cassava was only sold in sizeable quantities by households 8 and 13. These households both underwent significant consumption reductions in the model simulations (Table 4-5), and it was at these times of consumption reductions that these households

sold cassava. This suggests that cassava is only sold when households are under stress and need to sell potential household food in order to get cash to meet necessary requirements.

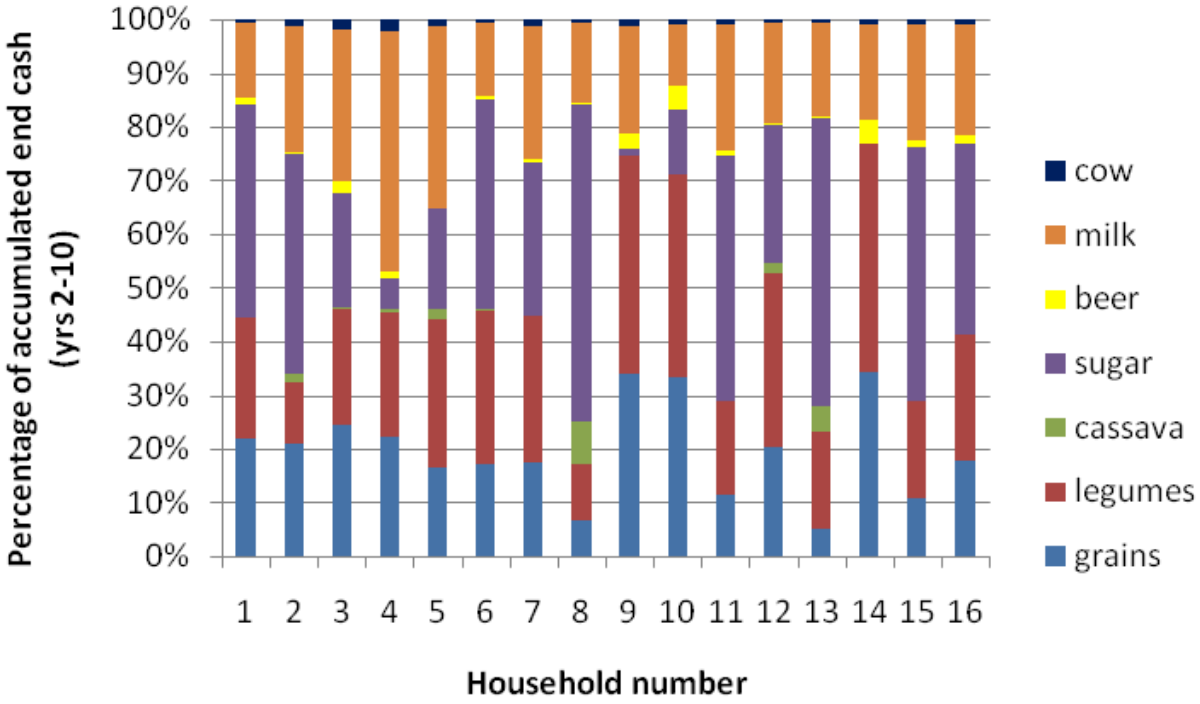

Figure 4-7. Percentage of accumulated end cash income for Amukura households from various livelihood activities (years 2-10)

Meanwhile, selling cow's milk was one of the best sources of income for households that were struggling, such as household numbers 4 and 5 (Figures 4-6 and 4-7). Cattle are a source of wealth that can be depended upon in times of hardship, and milk production was a valuable source of daily income for households who lacked other resources to meet end cash requirements.

Despite the differences between FHH and MHH in terms of food production and consumption, there is little difference between cumulative end cash of FHH compared with MHH in Amukura. Households 1 and 2, which contained a lot of youth labor in addition to the adult female(s), were able to generate more end cash than many of the

MHH. Households 3 and 4 were two of the worst off households that were modeled, yet this is due to the high number of children in early years of the model, which put these households under much stress at those times.

Table 4-7. Comparison of ranks of consumer/producer ratios (average of years 2-10) and end cash (year 10) for Amukura households

Household	C/P ratio average (yrs 2-10)	Rank (lowest to highest)	End cash (year 10)	Rank (highest to lowest
10	1.289	16	339736	3
11	1.355	15	308373	4
15	1.451	14	178829	8
13	1.481	13	350443	2
14	1.542	12	80738	9
1	1.544	11	270342	6
16	1.548	10	78976	10
9	1.565	9	32796	13
6	1.571	8	298025	5
8	1.573	7	382855	1
7	1.577	6	3118	16
2	1.610	5	203282	7
5	1.653	4	15393	14
4	1.869	3	57832	12
12	1.890	2	10448	15
3	1.988	1	68635	11

Analysis of the effect of household composition upon livelihood strategy adoption and end cash was further conducted by comparing the end cash values for each household for year 10 with consumer-producer (C/P) ratios. C/P ratios were calculated with the contributions towards labor that each household member brought (producer) and the consumption demands that each household member had (consumer). Comparing end cash in year 10 with average C/P ratios over time gave a Spearman's rank correlation coefficient of -0.61 indicating that these variables are strongly correlated (Table 4-7). It therefore becomes clear that C/P ratios indeed contribute to explaining the difference in end cash values amongst the diverse households.

Households with higher C/P ratios were more able to enter into cash-producing livelihood activities such as sugar cane production. This is linked to the notable importance of youths in raising household end cash. Households 1, 6 and 10 in particular had many youths throughout their model simulations, and this valuable extra labor that these youths brought to their households helped to generate a high amount of end cash in year 10.

School fee investment

For a household that helps put its youths through school, there is increased hope that the youths will assist the household in return in the future. Analysis of school fee investments by these diverse households is also important in understanding differences in end cash scenarios. Figure 4-8 indicates that a slightly different picture of which households are doing well and which are struggling in Amukura comes into effect when the cumulative cash invested into school fees for youths is taken into account alongside end cash. This figure highlights that households 7, 9 and 12, which had low accumulated end cash, had in fact invested significantly in their future well-being through school fees. Therefore, these households were not as badly off as end cash analysis without school fee investment suggested.

Households 1 and 10 – two households with high numbers of youths – were able to generate the most amount of money in terms of a combination of end cash and the cash invested in school fees, while households 4 and 5 – two households with many young children – generated the least amount of total money. This indicates another crucial impact of household composition - households that have older children are usually better off than those that have young children.

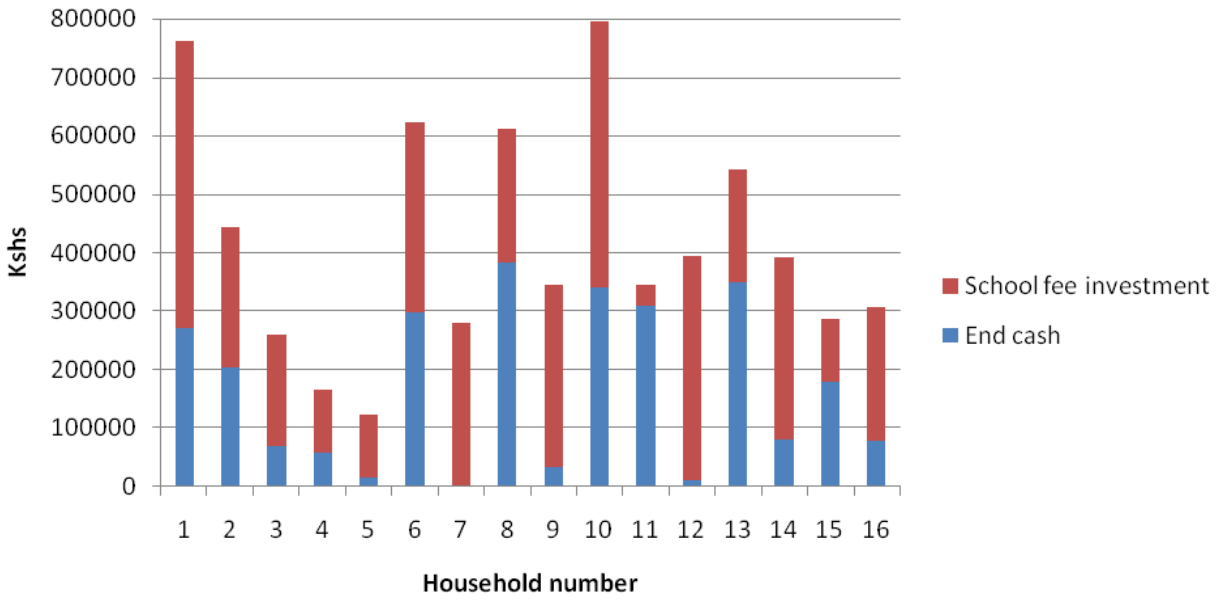

Figure 4-8. Cumulative end cash in year 10 and cumulative school fee investment (yrs 2-10) in Amukura households

Land

Land was a constraining factor for all households in Amukura. Fourteen out of the 16 households used all of their land in one or both semesters between years 2 and 10 (Feb-Jul or Aug-Jan) (Table 4-8). Household numbers 4 and 8 were the only households that did not use all their land in either semester. Household 4 did not have enough labor to work all of its land, whereas household 8 did not need to use all of its land to meet its reduced consumption requirements. Except for household 2, all households that did not use all their land every year were households that did not meet end cash or consumption requirements.

All households except households 1 and 2 rented-in land at some point (Table 4-8). Households 1 and 2 started in year 1 with 7 and 4.5 acres respectively, which was enough land to provide for these households without the need for renting extra land. Furthermore, both these households were FHH, and even the other two FHH (3 and 4)

did not rent much land when compared with most of the MHH. Renting-in land required significant inputs of cash (7000Kshs/acre), which was more difficult for the FHH to acquire than MHH. The three households that rented in the most land were households 9, 10 and 14 which had three of the lowest C/P ratios, and which also had three of the largest household sizes. Thus, these households had enough surplus labor to work the additional land that was rented.

Table 4-8. Land used, bought, and rented in Amukura (years 2-10)

Household	Average land use percentage		Total rented in (acres)		Total rented out (acres)		Total bought (acres)
	Feb-Jul	Aug-Jan	Feb-Jul	Aug-Jan	Feb-Jul	Aug-Jan	
1	100	100	0	0	0	0	0
2	98	100	0	0	1	0	0
3	98	100	0	2	1	0	0
4	95	96	1	4	2	2	0
5	94	100	4	9	1	0	0
6	100	100	1	12	0	0	0
7	100	100	2	11	0	0	0
8	94	94	1	8	3	3	0
9	100	100	7	17	0	0	0
10	100	100	3	17	0	0	0
11	100	100	0	5	0	0	1
12	100	100	0	4	0	0	0
13	94	100	0	1	3	0	0
14	100	100	7	18	0	0	0
15	100	100	5	10	0	0	1
16	100	100	3	11	0	0	1

Renting-in land was a more common livelihood strategy option adopted in the second semester (August-January), when available household land for the majority of households was already being fully utilized. The need for households to make enough money to meet household end cash needs at the end of the second semester was also a contributing factor towards more land being rented in the second half of the agricultural year.

Households that had unused available land in a certain year rented out this land for cash. There were six households that did this in the first semester, but only two in the second semester. Households that rented out land were ones that could not utilize all their land due to lack of available household labor. This land that was rented out was a source of land for rent by other households in Amukura. The other principal source of land for rent was from people who worked and lived full-time in urban areas, who still had land holdings in Amukura which they rented out for cash.

Finally, only three households – 11, 15, and 16 – could afford to buy an additional acre of land. These households had the necessary cash to acquire the land, and were also households that were under significant land stress as they all began with three acres or less of their own land in year 1. Therefore, in addition to renting, purchasing land was a profitable livelihood strategy to adopt for these households.

Labor

Labor was also a constraining factor for most households in Amukura. The nine months between February and October are the busiest months when almost all available labor is used in every household. November to January is the least busy period, which corresponds with the main dry season in Amukura (Table 4-9). Households that did not use all their available labor on average in any season were either ones that were constrained by land (households 5, 7, and 10) or ones that had reduced their consumption requirements because of constraining gender-specific labor (households 8 and 13). Households 8 and 13 were both constrained by their lack of available female labor, so even though these households used all available female labor, not all the male labor was used. The four households that used all their labor in every season in all years were households 1, 2, 3 and 4 – the four FHH. These

households responded to their labor constraint by being only four of eight households to hire labor in Amukura. These FHH hired labor because it was the most reliable and available method for them to obtain the necessary male labor for the livelihood strategies they had adopted. The only other households to hire labor were households 8 and 13, which both required additional labor to help produce food that did not require female-specific labor, and households 11 and 16, which both generated enough cash to hire labor to work a larger acreage.

Table 4-9. Average percentage of available labor used and total number of hired days per season for Amukura households (years 2-10)

Household	Percentage of available labor used				Total number of hired labor days				
	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Total
1	100	100	100	100	0	11	33	0	44
2	100	100	100	100	9	35	67	85	195
3	100	100	100	100	0	9	0	10	19
4	100	100	100	100	16	50	8	51	125
5	92	94	100	70	0	0	0	0	0
6	100	99	100	84	0	0	0	0	0
7	91	93	99	72	0	0	0	0	0
8	94	96	100	82	0	0	48	0	48
9	100	100	100	87	0	0	0	0	0
10	97	95	95	77	0	0	0	0	0
11	100	100	100	98	0	0	7	3	9
12	100	96	100	71	0	0	0	0	0
13	88	88	96	80	0	0	4	0	4
14	100	100	100	93	0	0	0	0	0
15	100	95	100	94	0	0	0	0	0
16	100	99	100	92	0	0	21	0	21
Average %	98	97	99	87					
Total number of days					25	104	189	149	466

Mwatate

Food production/consumption

Household composition was arguably the most important factor in understanding the differences in food production strategies adopted by diverse households in Mwatate. Whereas all households produced similar proportions of maize, cassava and vegetables for home consumption, the variations in food production strategies were in the differential adoption of legumes. All households adopted some mixture of beans, groundnuts and pigeon peas as livelihood strategies to provide legumes for their household. However, many of these households favored one strategy in particular over another.

Only five households (1, 3, 11, 12 and 16) included these three legumes as at least 10% each of their household diet. These households adopted this balanced strategy due to household composition. Households 1, 3 and 12 adopted this strategy due directly to their household compositions – all three households had high numbers of female adults and youths throughout all 11 years of the model. On the other hand, households 11 and 16 adopted this balanced legume strategy as they had plenty of end cash which could be invested in multiple legume production strategies to spread risk. This high amount of end cash that both these households generated was directly linked to their household compositions. These households were small and young in terms of average age of household members and therefore had low consumption demand. Consequently, these households could save up money from cash-producing strategies to invest in multiple additional strategies in later years.

End cash

The most apparent distinction between household end cash results in Mwatate and those in Amukura was that Mwatate households typically had lower end cash values (Figure 4-9). This indicated that in general households in Mwatate were worse off financially than Amukura households. Mwatate lacked a cash crop that was as dominant as sugar cane in Amukura. Although Mwatate households were not devoid of cash crop strategies, the lack of a major company such as Mumias Sugar and the potential contracts it offered to farmers willing to grow sugar cane could partly explain the occurrence of much lower end cash scenarios in general in Mwatate.

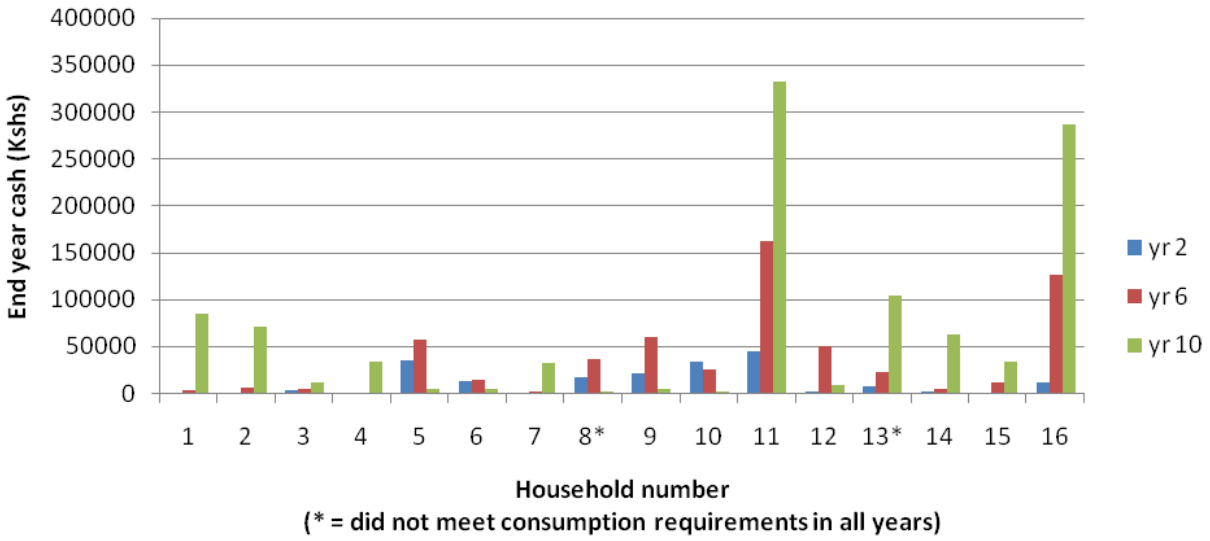

Figure 4-9. Accumulated end year cash in years 2, 6 and 10 for Mwatate households

Only households 11 and 16 had significantly larger end cash values than the other households in Mwatate. These small, young households benefited in particular from their ability to plan for the future. They could do this by saving money in the earlier years, which allowed them to plan for the changes in their composition in the future. Thus, when stress came to these households, they were well prepared and had

invested wisely in certain cash-producing activities that allowed them to continue to reap rewards of increasing end cash. These households therefore adopted different livelihood strategies when compared with other households in Mwatate. Households 11 and 16 increased their cash income through both focusing primarily on legume production, as well as at the same time diversifying production rather than focusing on one product for sale continually. Household 11 switched from primarily maize for sale in early years to a diversified base of a variety of legumes, including cowpeas, pigeon peas, beans and groundnuts, as well as selling cassava, beer, and milk. Household 16 followed a similar strategy, yet continued to focus on maize production for sale.

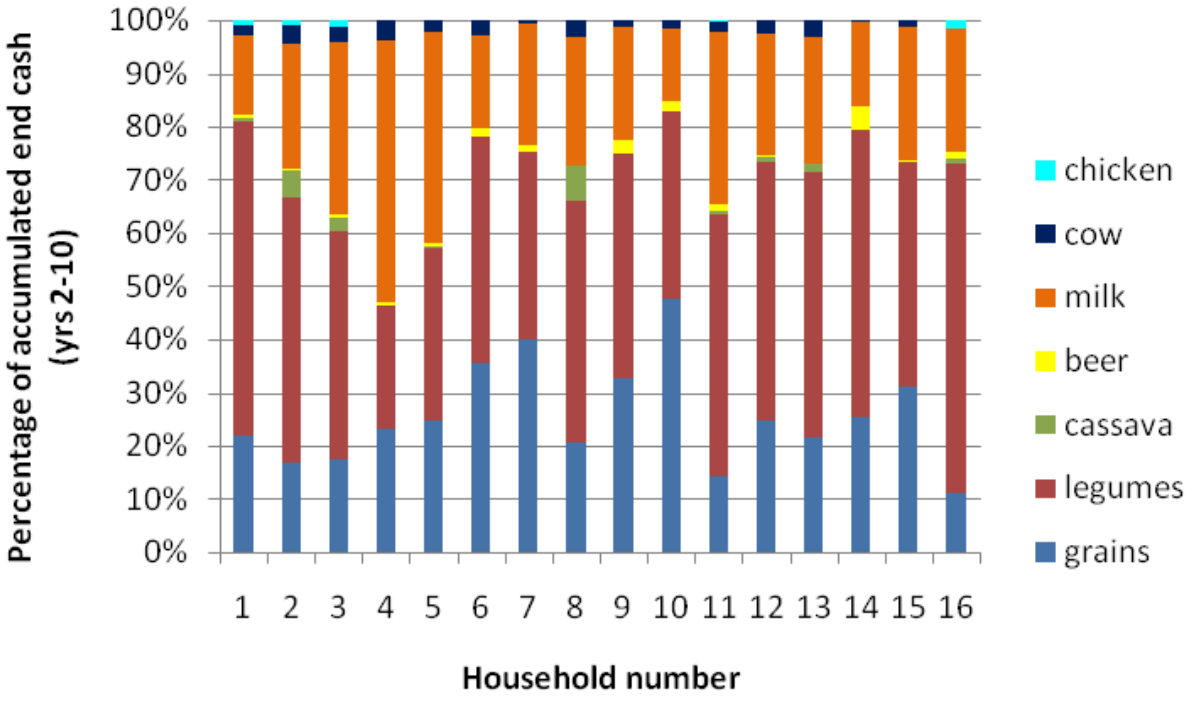

Figure 4-10. Percentage of accumulated end cash income for Mwatate households from various livelihood activities (years 2-10)

Although there is a more distinct difference between FHH and MHH end cash results in Mwatate than in Amukura, there is less of a distinction in Mwatate than Amukura between FHH and MHH livelihood strategy adoption. For instance, in Amukura

household numbers 1 and 2 were able to make large amounts of end cash, while FHH in Mwatate were unable to generate much end cash. Meanwhile, FHH in Amukura had distinct differences in grain and legume adoption when compared with MHH – this was not the case in Mwatate. However, the FHH in both Amukura and Mwatate that was able to generate the most end cash was household 1 – the household with two adult females. Therefore, for both communities FHH are better off when there are more adult females in the household, suggesting that when a male leaves behind multiple wives or when two single-female headed-households band together, the new household is better off than those FHH that are dependent upon a single adult female.

Overall, legume production for sale brought a larger share of the cash income to most households in Mwatate than grains or any other enterprise (Figure 4-10). Pigeon peas, cowpeas, and beans were typically the crops that had surplus for sale, whereas only households with a larger supply of labor, such as household 1, produced surplus groundnuts or green grams. This was due partly to the low price of grains and the much higher relative price of legumes. Also, the semi-arid climate of Mwatate made growing drought-tolerant legumes a more reliable alternative than producing grains such as maize for sale. Similar to Amukura, selling milk was the main contributor towards end cash of households that are worse off financially, such as households 3, 4 and 5. These households were under the most stress and typically had fewer resources to produce cash crops. Whereas cows were kept and sold by the majority of households, chicken production for sale was restricted to only five households. These were households 1, 2 and 3, which were FHH and had plenty of female labor (necessary for chicken production), and also households 11 and 16, which had generated the most end cash

and so had enough money to invest into poultry production as an additional livelihood strategy.

Consumer/producer (C/P) ratio analysis also confirms that household composition was a significant factor influencing differences in end cash scenarios in Mwatate. Comparing the ranking of the C/P ratio average over years 2-10 and the ranking of end cash in year 10 gave a Spearman's rank correlation coefficient of -0.56, which is similar in strength to that of Amukura (Table 4-10). Households 11 and 16 were notably the two with the lowest C/P ratios. This C/P analysis highlighted that households with a lower C/P ratio were more likely to have greater end cash.

Table 4-10. Comparison of ranks of consumer/producer ratios (average of years 2-10) and end cash (year 10) for Mwatate households

Household number	C/P ratio average (yrs 2-10)	Rank (lowest to highest)	End cash (year 10)	Rank (highest to lowest
11	1.355	16	332072	1
16	1.451	15	286447	2
13	1.508	14	105400	3
10	1.541	13	2923	15
7	1.555	12	32974	9
1	1.599	11	85407	4
15	1.601	10	33986	8
9	1.664	9	5015	13
4	1.686	8	34043	7
2	1.704	7	71404	5
5	1.727	6	5012	14
14	1.751	5	62861	6
6	1.764	4	5426	12
8	1.862	3	2830	16
12	1.880	2	10279	11
3	1.988	1	12261	10

Going beyond the C/P analysis, the number of children in a household was also crucial in explaining differences in end cash results and adoption of livelihood strategies by households in Mwatate. The more children in a household, the more that household

struggled to make significant amounts of end cash. The seven households with the lowest end cash in year 10 include household numbers 3, 5, 6, 8, 9, 10 and 12. All of these households have at least two children for at least seven out of the 11 years.

School fee investment

Similar to Amukura, by considering school fees that households made as an investment in the future well-being of the household and its members, Figure 4-11 highlights that some households that appeared to be struggling due to low end cash in year 10 had in fact invested heavily in school fees. The most notable households that had done this in Mwatate were households 1, 10, 12 and 14. All four of these households had many youths and used a large proportion of their potential end cash to invest in the future of their youths.

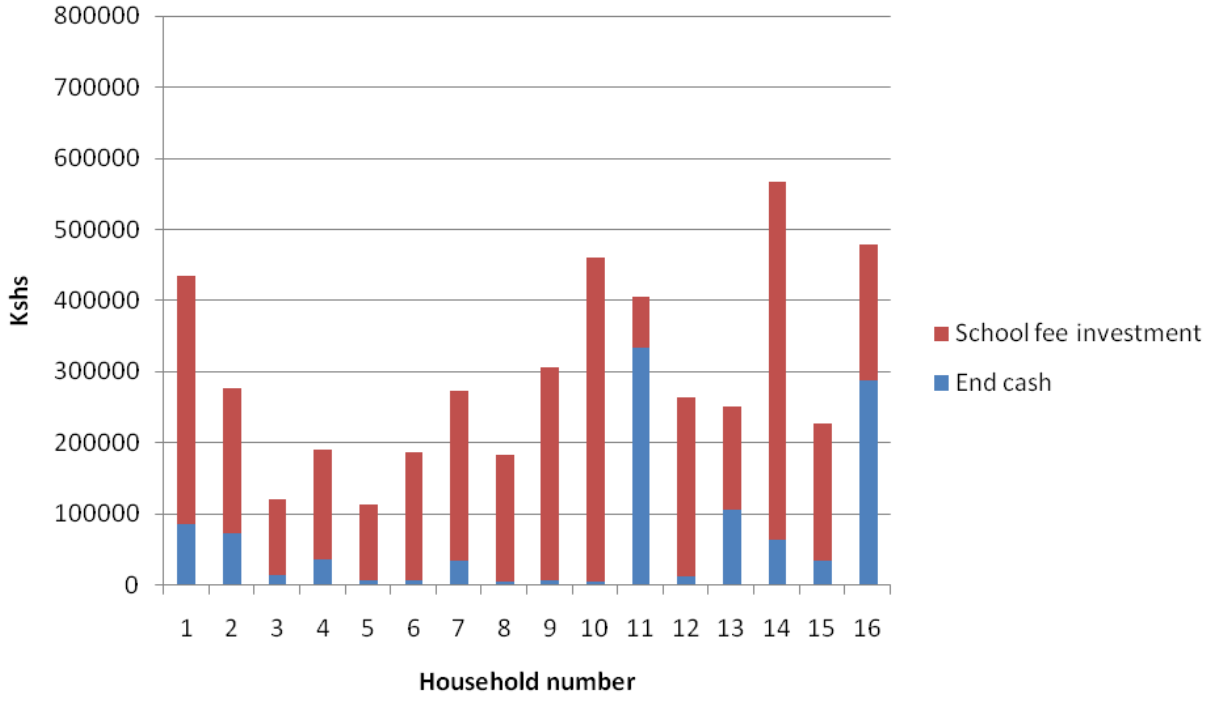

Figure 4-11. Cumulative end cash in year 10 and cumulative school fee investment (yrs 2-10) in Mwatate households

Meanwhile, households 3 and 5 had generated the least amount of accumulated end cash with school fee investments, and both of these households were ones with many young children. This reinforces the finding from Amukura that households with older children are generally better off financially than those with younger children. However, when compared to Amukura, eight households had to remove youths from school at some point during the model simulations compared with only three households in Amukura (Tables 4-5 and 4-6). This reinforces that in general households in Mwatate were worse off than their Amukura counterparts.

Land

Land was also a constraining factor in Mwatate – 13 out of the 16 households used almost 100% of their available land in both semesters (Table 4-11). The only three households that did not use almost 100% of their land in both semesters were households 2, 8, and 13. Household 2 was the only household that was not land constrained. This household began the first year with five acres of land and only had four household members. Therefore, there were not enough household members to work all the land, nor did this household need to use all of its land to meet household end cash and consumption requirements.

Households 8 and 13 did not use all of their available land in the first four years. In these years, both households were unable to meet consumption requirements and had to reduce their food intake by 40%. Although both households had enough land to produce the food required, their other resources of labor and cash were not enough to help them produce this necessary food, therefore some of their land in these four years was left fallow.

Table 4-11. Land used, bought, and rented in Mwatate (years 2-10)

Household number	Average land use percentage		Total rented in (acres)		Total bought (acres)
	Feb-Jul	Aug-Jan	Feb-Jul	Aug-Jan	
1	100	97	0	0	0
2	83	84	0	0	0
3	99	99	0	0	0
4	100	100	0	0	0
5	100	98	0	0	0
6	100	100	0	0	0
7	100	100	0	0	0
8	82	77	0	0	0
9	100	100	0	0	0
10	100	100	0	0	1
11	100	94	0	0	1
12	100	95	0	0	0
13	88	86	0.02	0	0
14	100	100	0.08	0.15	0
15	100	100	0.11	0.21	0
16	99	97	0	0	0

Renting-in land was very unusual amongst Mwatate households – a significant difference from Amukura. This was due to the high price of rental land in Mwatate (10000Kshs per acre) which was almost double the cost of rental land in Amukura (7000Kshs per acre). The only land that was usually sought after for renting in Mwatate was in the intensively-managed wetland which occupied only a small area of the total land in Mwatate. This land was too expensive for all households except households 13, 14 and 15 who were able to rent a tiny portion of this land toward the end of the 11 years, when they had more cash at their disposal. Renting out land was therefore very uncommon in Mwatate, except for in the fertile wetland area. However, very few households owned or had access to this fertile land, and those who owned this land very seldom rented out this valuable land, but instead usually used it for their own

agricultural production. None of the households modeled in this study owned any of this wetland acreage.

In addition, the practice of buying land in Mwatate was only adopted by a minority of households, similar to Amukura. Household numbers 10 and 11 were the only two households to buy one acre of land. Both households were able to save enough money to purchase an acre, even though they had very different compositions and available resources – household 11 started with only three acres and required more to help feed its growing family, and household 10 started with eight acres but had high demand on land due to its large household size.

Labor

Similar to Amukura, labor was also a constraining factor for most of the households in Mwatate. The least busy period in Mwatate, however, was the first dry season, between May and July. The other nine months of the year were typically very busy for most households (Table 4-12), especially November-January when households are trying to make as much money as possible in order to meet end cash requirements for each year. The vast majority of labor hired in Mwatate was during this three-month period, providing further evidence that this was the busiest time of year.

Four households in particular had excess labor throughout years 2-10. Of these four, households 8 and 13 were constrained by lack of available female labor, whereas households 5 and 15 were land constrained. The only two households that used all their labor every season every year were households 1 and 2 – both FHH. These two households were also the ones that hired the most labor over the course of years 2-10 (Table 4-12). There were also two other households that hired over 150 days of total labor over years 2-10 – households 3 and 12. Similar to households 1 and 2, household

3 was a FHH which lacked available male labor. Meanwhile, household 12 had a low producer/consumer ratio and many young mouths to feed, so had to hire a lot of labor to meet household needs. Not all FHH in Mwatate hired a lot of labor (unlike Amukura). This is because household 4 was unable to hire labor until the last three simulated years due to lack of cash.

Table 4-12. Average percentage of available labor used and total number of hired days per season for Mwatate households (years 2-10)

	Percentage of available labor used				Total number of hired labor days				
Household number	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Total
1	100	100	100	100	14	0	0	316	330
2	100	100	100	100	32	10	0	298	340
3	100	98	100	100	21	27	0	192	240
4	98	92	97	100	0	0	0	28	28
5	96	86	98	100	0	0	0	33	33
6	100	92	100	100	0	0	0	1	1
7	100	94	100	100	0	0	0	0	0
8	93	77	95	94	32	0	0	50	82
9	100	97	100	100	0	0	0	61	61
10	100	94	100	100	0	0	0	0	0
11	100	98	100	100	8	0	0	2	10
12	100	97	100	100	22	0	0	168	190
13	80	58	70	82	0	0	0	5	5
14	100	98	95	100	0	0	0	24	24
15	91	66	82	94	0	0	0	0	0
16	100	96	100	100	0	0	0	54	54
Average %	97	90	96	98					
Total number of days					128	37	0	1233	1398

Summary and Conclusions

This chapter has answered Research Question 1 through providing a detailed description of the livelihood systems of both Amukura and Mwatate, as well as an in-depth analysis of livelihood strategies adopted by diverse households operating within

these systems. Even though all households in each community operate within the community livelihood system, there is tremendous diversity of household decision-making in terms of livelihood strategies due to household composition, which in turn influences both differential resource availability and household cash and consumption requirements. This diversity of decision-making is also dynamic as household resources and requirements change over time.

Livelihood strategies adopted by households in both Amukura and Mwatate were directly linked to household end cash, assuming the goal of every household was to maximize end cash in the last year of the ELP model analysis. In Amukura, end cash values were linked to the production and sale of sugar cane, the principal cash crop of the area. Households that produced sugar cane were more likely to have higher end cash. In Mwatate, end cash values were not as high as for households in Amukura, in part due to the lack of a dominant cash crop such as sugar cane. Households in Mwatate focused primarily on a mixture of legumes, grains, and milk production for generating end cash.

Livelihood strategies adopted by households in both communities were also affected by resource availability. Households in both livelihood systems were land constrained – the majority of households were using all of their available land most of the time. In this context, the ability for households to rent and/or buy parcels of additional land for production was crucial in determining livelihood strategies adopted.

Labor was also a limiting factor for the majority of households in both communities. Labor was especially constraining between February and October in Amukura and between August and April in Mwatate. The lack of female labor for certain gender-

specific activities was also a severe limitation for some households. This was a particular problem as female labor was needed for food crop production and preparation. As only males could be hired for additional labor, there was no way to provide extra female labor for these households. Therefore, households that did not have enough female labor were forced to reduce food consumption.

Hired labor was utilized by some households, especially FHH that required additional male labor to complete certain male-specific production activities. However, many households lacked the cash resources to hire labor, while other households had no access to additional acreage on which hired labor could work. Sparse cash resources not only limited households' ability to hire labor and/or rent and buy land, but also restricted some households' abilities to afford school fees for youths. Households that had to remove youths from school due to lack of cash for fees included households that already had to reduce food consumption as well as households that had high numbers of youths.

Household composition, however, is arguably the most important dynamic factor that affects livelihood strategy adoption in both communities. Household composition directly affects household labor availability as well as cash and consumption requirements. For example, the differences in household composition between FHH and MHH in both communities led to the adoption of distinctly different strategies. FHH were typically more constrained by labor than MHH, and often resorted to hired labor in order to meet cash and consumption requirements. However, MHH who lacked enough female labor were also constrained in what activities they could adopt.

Slight changes in the intricate balance of household resources and constraints can be the difference between struggle and survival. For example, household number 8 in Mwatate had to reduce consumption by 40% in years 1-4, yet only by 10% in years 5-7. This shift toward increased household food security was not a result of an intervention, but occurred due to a slight change in household available resources, constraints, and composition. In year 5, one of the children in the household had grown up to be a female youth, and the additional female labor that this youth provided made the difference to increase this household's food consumption.

Overall, the food security situation in these communities is similar in some respects while being very different in other respects. Both communities contain a diverse set of households, of which some were able to meet household requirements while others were unable and had to either reduce food consumption or remove youths from school. However, the main distinction lay in that while more households had to reduce consumption in Amukura, more households in Mwatate were unable to meet school fee requirements. Thus, struggling households in Amukura typically lacked food resources, while struggling households in Mwatate more often lacked cash resources.

All households in both Amukura and Mwatate therefore operate within a tight budget with limited resources. These households are subject to a complex mix of dynamic, interacting constraints which have created diverse patterns of decision-making concerning livelihood strategy adoption. It is into these two community contexts that grain amaranth is being introduced. Focus in the following chapters will be upon grain amaranth and its potential acceptance and adoption by diverse households within these communities.

CHAPTER 5
ACCEPTANCE OF GRAIN AMARANTH

Introduction

Before analyzing the potential adoption of grain amaranth in Chapter 6, it is important to first assess the current acceptance of grain amaranth by households in the two studied communities. This chapter addresses Research Question 2, which asked:

- RQ2: What are the social attitudes towards grain amaranth in Amukura and Mwatate?

This question will be addressed by first reviewing the theoretical background to acceptance of an innovation, paying careful attention to the distinction between acceptance and adoption. Then, factors affecting the acceptance of a new food are discussed, before analyzing these factors with reference to grain amaranth in Amukura and Mwatate.

Theoretical Background

Innovation Acceptance

Although Rogers' (1983) theory of innovation adoption has been largely discredited for being a model of linear top-down development, his theory is useful in building our understanding of decision-making processes regarding an innovation. Rogers' theory noted that acceptance of an innovation involves attitudes that contribute towards a decision about whether or not the innovation could and should be adopted, to what degree it should be adopted and for what purpose.

However, the personal attitudes of the potential user are not the only factor influencing acceptance of an innovation. Instead, a key factor in understanding acceptance is the interaction of the potential user of the innovation with other agents

and institutions. In order to consider these interactions, behavioral theories that go beyond the diffusion of innovations theory must be considered. Fishbein and Ajzen's (1975) theory of reasoned action suggests that a person's behavioral intention (such as the intent to accept an innovation) depends on both the person's attitude about the behavior and subjective norms. Extending this theory to the acceptance of an innovation implies that acceptance depends not only upon personal attitudes towards the innovation but also upon the attitudes of others in the community that shape a person's thinking. However, Sheppard, Hartwick & Warshaw (1988) have leveled a major critique of this theory claiming that it does not account for choice among alternatives. The existence of available alternatives that may be perceived to be better than the innovation may greatly affect the acceptance of the innovation.

Differentiating Acceptance and Adoption

A critically important distinction must be made before continuing. In much of the literature, the terms acceptance and adoption are used interchangeably. However, acceptance and adoption are not the same and relate to different parts of the process of diffusion of an innovation. Rogers' and Fishbein and Ajzen's theories importantly highlight that some form of acceptance of an innovation has to come before the innovation is adopted, if indeed adoption is based on the voluntary choice of an individual. Acceptance in the context of voluntary choice is thus a pre-requisite for adoption.

Adoption is made up of many things, of which acceptance is only one part. Another part of adoption is the influence of context or environment upon an innovation. The effects of dynamic physical, socio-cultural and economic environments can greatly influence adoption of an innovation. Adoption is also concerned with the use of an

innovation. Adoption of an innovation could be for a variety of different uses, dependent on the priorities of the adopter. Furthermore, adoption of an innovation also encompasses adaptation – how an adopter will choose to adapt the innovation to meet his/her needs or preferences.

Whereas acceptance is more about attitudes and behaviors, adoption is more about action, which is influenced in part by acceptance. Therefore, adoption is more complex than acceptance and care must be taken to distinguish between the two. In this chapter, the discussion will focus on the subjective acceptance of grain amaranth by diverse households in the two studied communities, with an appreciation that understanding factors affecting acceptance will develop a deeper understanding of patterns of adoption of grain amaranth, to be explored in Chapters 6 and 7.

Factors Affecting Acceptance of a New Food

There are several different theoretical models of food choice, which all argue that a person's choice of foods to eat is a complex decision (EUFIC, 2005; Furst *et al.*, 1996). Acceptance of a new food is subject to a range of both individual and community level factors that affect personal and household decisions on whether or not to choose this new food. This choice ultimately is structured by the impact of what Furst *et al.* (1996) describe as "life course," implying that a person's upbringing in a particular cultural setting is the starting point for personal food choices. Consequently, cultural foods and traditional meal habits provide the context for the influences upon personal food choices.

Bringing the various models of food choice together, there are three major groups of influences that affect food choice – socio-cultural, bio-physical, and economic. All of these influences are dynamic, varying in importance to an individual across space and

time. Equally important is that different individuals are affected to varying degrees by these influences. Although these three groups of influences are presented here as distinct, they are all interrelated and overlap to some degree.

The first of these groups is socio-cultural influences. This group encompasses two distinct factors, the first of which is cultural ideals, expectations and standards about food. The main cultural ideal that influences food choice is the concern with what constitutes a “proper” meal. Cultural standards also put values and meanings on different food products. This may lead to certain foods being associated with a certain social status, or a certain event such as a holiday or ritual observance. The second distinct factor is the impact of social relationships and interactions upon food choice. Interpersonal relationships within households and families play a significant role in determining food choice. These relationships involve conflicting priorities and preferences and are structured around issues of power. The social framework thus influences food choice through factors such as who decides what a household eats, who prepares the food, what are the cultural taboos and myths surrounding certain foods, and what foods are others in the community choosing to eat.

The second group that affects food choice is bio-physical personal influences. Personal preferences, determined by taste, likes/dislikes, individual foodstyles, and emotions all influence food choice. People often have individual standards about food quality which may affect what they choose to eat. Furthermore, personal characteristics such as gender, age, state of hunger and health status all impact decisions concerning what foods to consume. Most people have a sense of what constitutes a healthy and nutritious diet and this leads to the selection of certain foods.

The third and final group that affects food choice is economic influences. Diverse households have different levels of critical resources available to them, such as cash, land and labor. This strongly influences their choice of foods. Choices about foods will depend on whether a household has enough money to buy a certain food, or enough land and labor to produce the food. Food context is also critically important in understanding the impact of economic influences upon food choice. Food context involves issues of price changes and market availability. Food choice is strongly determined by seasonal availability of foods, as well as seasonal and annual changes in prices of certain foods.

These influences over the life course lead to individuals and communities developing personal and communal systems of food choice. These systems are founded upon a resolution of value negotiations between these three groups of influences. These systems involve increasingly defined strategies of food choice that lead to habitual patterns. These habits are difficult to break and are consequently a major obstacle towards the acceptance of a new food.

Factors Affecting Subjective Acceptance of Grain Amaranth

The three groups of influences of food choice affect the subjective acceptance of grain amaranth into rural Kenyan communities. Prior to the introduction of grain amaranth, habitual food choice strategies have been formulated among rural Kenyan households. Therefore, key to the acceptance of grain amaranth is the need to break into household food choice systems, so that grain amaranth may become a food that is habitually selected. Discussions with community members in Amukura and Mwatate in both individual household settings and focus groups revealed the complexity of factors that influence the acceptance of grain amaranth. The most important group of

influences in both communities was socio-cultural factors. However, bio-physical and economic factors were also important and will be discussed in turn.

Socio-Cultural Influences

Discussions with community members in both Amukura and Mwatate revealed that socio-cultural influences are the most important in determining whether or not community members would accept grain amaranth as a new food. Five socio-cultural influences were identified – prior knowledge of amaranth, the source of amaranth information, the communication of amaranth information, community myths about amaranth, and how amaranth fits into the cultural ideal of what constitutes a proper meal.

Prior community knowledge of amaranth

Prior to the grain amaranth promotion project initiated by CRWRC/ACK in Amukura and Mwatate, grain amaranth was not widely known. This is still the case throughout a large area of these divisions, though this situation is changing. *Amaranthus spp.* grows in the wild in Kenya and was a traditional foodstuff of past generations. This wild amaranth was collected for its leaves which can be cooked and eaten as a boiled vegetable, similar to spinach. Most people in both Amukura and Mwatate that were interviewed knew amaranth as this vegetable called "*mchicha*". Mchicha is still a common vegetable grown in both areas. The seeds are broadcast and then plants are harvested for their leafy biomass when only 2-3 weeks old.

Apart from those people who had heard about grain amaranth already through CRWRC/ACK's promotion efforts, people's knowledge about grain amaranth in these communities was sparse. Many were not aware that there were species of amaranth that could produce edible grain. Those who were aware of this fact typically knew of it

as a crop that their grandparents or previous generations had grown and used as a good source of nutrition. Interviewees suggested that their ancestors had often eaten amaranth grain in the form of porridge, and did not know exactly why the crop had since been abandoned, though many reasons were suggested including lack of seed, lack of market, preference for other foodstuffs such as cassava and maize, and lack of land.

Source of information

The source of information about any new innovation or technology is always a critical factor in determining its acceptance in a community. Grain amaranth promotion is occurring not only through CRWRC/ACK but also with assistance from the Kenyan government's Ministry of Agriculture (MoA) and a complex network of community social relationships. The source of information brings up issues of trust, curiosity and fear. These issues shall be looked at with regards to the various sources from which community members in both Amukura and Mwatate were receiving information about grain amaranth.

The most prominent source of information about grain amaranth in both Amukura and Mwatate is the ACK's Community Development Facilitator (CDF) for that division. The CDF is responsible not only for grain amaranth promotion but also a wide range of relief and development project initiatives operated by the ACK in the CDF's division. The CDF is a member of the ACK and also resident in the division. The CDF is almost always from the same ethnic group as the predominant ethnic group of that division, and if not native to that exact division, is usually from a nearby division. The CDF's role in promoting grain amaranth in his/her division is to encourage households in the division to adopt grain amaranth as a livelihood strategy. The CDF's methods include, amongst others, visits to individual households through a standard extension strategy,

meetings and discussions with farmer groups, and community field days and cooking demonstrations.

The relationship between the CDF and the community is very different in Amukura compared with Mwatate. Bunch (1995) has listed six attributes of an effective promoter in a community – motivation to help others, enthusiasm, technical knowledge, conviction, prestige, and teaching ability. More of these attributes are apparent in the Amukura CDF with relation to the grain amaranth promotion efforts, compared with the Mwatate CDF. In Amukura, the CDF has been promoting grain amaranth since 2003 and continues to do so actively in his community. He grows grain amaranth on his own land and eats it often for dinner as an ingredient in ugali. He is therefore very enthusiastic about the benefits of grain amaranth. In addition, this CDF is well-respected and well-known in his community and his strong promotion of grain amaranth has earned him the nickname of “Mr. Amaranth” in his division, despite the other programs in which he also invests his time. The investment that the CDF is putting in his community in terms of time and willingness to talk about grain amaranth is creating a climate of acceptance and adoption. Trust in the CDF amongst community members is high due to his detailed knowledge about grain amaranth and the community, openness to share with his community, and the way he practices what he preaches by producing and eating grain amaranth. He is also able to convey messages to his community about grain amaranth in a simple-to-understand and effective manner.

In contrast, the CDF in Mwatate had been promoting grain amaranth in his division, but the promotion program has slowed in recent years. Discussions with Pwani-CCS/ACK staff including the Mwatate CDF revealed a difficult situation with the

community. They reported that the insistence of community members on cultivating maize and devoting little time or attention to grain amaranth efforts had resulted in low rates of acceptance and adoption. The CDF had utilized the same methods as the CDF in Amukura is still using. However, he attested that the Mwatate community held strong cultural barriers to a crop that was perceived to them as new. When interviews and group discussions for this research were conducted with community members in Mwatate, another picture was painted that revealed a flip side to this tale of events. Community members reported the numerous difficulties they faced with cultivating grain amaranth and admitted their lack of knowledge about the crop. They also indicated that not all these difficulties had been and continued to be properly addressed by the CDF and Pwani-CCS/ACK. Community members who reported these issues appeared frustrated with attempts to produce grain amaranth and had switched back to more traditional grain crops such as maize and sorghum. These discussions have highlighted a crucial part of the problems Mwatate's grain amaranth promotion program is facing, in that a climate of tension appears to have developed between the community and the CDF/ACK.

Both the CDFs are associated with the ACK. Although in most of both divisions the majority of people identify themselves with Christianity, there are also sizeable populations of Muslims and those of other religions. Depending on the value that an individual affords to this factor, this issue of religion can be a factor influencing the grain amaranth promotion efforts of ACK. This is a difficult factor to overcome but the CDFs in both divisions are overcoming this through actively promoting grain amaranth amongst

households and groups in their communities with an attitude of respect and humility regardless of religious status.

Though the most prominent, the CDFs are not the only grain amaranth promoters in Amukura or Mwatate. In both districts, the ACK has partnered with government Ministry of Agriculture (MoA) efforts to promote new technologies and innovations, including grain amaranth. The most common method the MoA uses is field days held at the farm of a prominent community member, to which all community members are freely invited to participate and share. However, the CDFs have to tread a fine line when linking with government activity. In any community, there are certain amounts of trust/distrust and fear/respect of government and initiatives supported by government. Community members who have had bad experiences with the government may be put off from accepting grain amaranth if it is seen to be linked with government extension campaigns - but similarly, the reverse is also true.

Neighbors, friends and relatives are also critical sources of information about grain amaranth and highly influential in the acceptance of the crop by other households in each division. The recommendation of grain amaranth by someone who is considered trustworthy goes a long way towards the acceptance of grain amaranth by a new household. Such social networks also spark curiosity and interest when something new is accepted and adopted. Visits to someone's home may result in a person noticing grain amaranth being cultivated and/or eaten and may encourage that person to try growing or eating grain amaranth for themselves as well. These networks are of great significance in both Amukura and Mwatate. Many respondents in individual household interviews and focus group discussions indicated that encouragement and persuasion

from someone they trust goes a long way towards convincing them to try something for themselves. Furthermore, if someone observes that grain amaranth is indeed a viable strategy for other households, they are encouraged that maybe it could be a viable strategy for their household too.

Communication of information

Related to the source of information, the communication of information about grain amaranth also importantly affects acceptance. A study by Chitere (1985) in rural Western Kenya showed that an agricultural innovation is more likely to be accepted and adopted when farmers were exposed to more intense promotion efforts. Households and individuals that have been exposed to a high intensity of grain amaranth promotion efforts in both communities were more accepting of grain amaranth as a potential livelihood strategy option.

The methods of promoting grain amaranth in both communities also had a major impact on its acceptance. Multiple methods to promote the grain were employed by partner organizations and by community members who already had knowledge of and experience with the grain. Field days and workshops were common methods used, both of which generally focused on issues of grain amaranth production. The most influential methods, however, were cooking demonstrations and personal testimonies about grain amaranth. Cooking demonstrations involved a few community members preparing a variety of traditional foods made with grain amaranth, such as *ugali*, *mandazis* (fried donuts), chapattis, and popped amaranth. These demonstrations were very popular with the communities (especially as the food was typically given away for free) and a large proportion of grain amaranth advocates indicated that cooking demonstrations had led them to accept grain amaranth. Personal testimonies were also particularly influential,

especially in Amukura amongst people living with HIV. Those who testified about grain amaranth highlighted that since they had started to eat the grain on a regular basis, they had become healthier. Such testimonies encouraged many more to consider accepting grain amaranth.

Community myths

The acceptance of grain amaranth is strongly influenced by perceptions and constructions of the crop by community members. In both communities, there were several ideas about grain amaranth that all had roots in facts about grain amaranth. However, these ideas had been mixed with other community beliefs and perceptions, leading to the construction of community myths about grain amaranth.

The first set of myths about grain amaranth that exist in both Amukura and Mwatate link grain amaranth to issues of sex and fertility. In both communities, there is a high incidence of HIV/AIDS. Promoters of grain amaranth (ACK and other groups and people) have often highlighted the health benefits from including grain amaranth in daily diets. This health focus has often emphasized the benefits of eating grain amaranth for those individuals living with HIV/AIDS in the nutritional boost it can give their diets. This emphasis has had profound impacts in the communities with many people living with HIV/AIDS incorporating grain amaranth into their diets and witnessing the beneficial effects of this. However, this emphasis has also had an unintended consequence of creating a community myth that grain amaranth is a crop only for the sick, or only for those living with HIV/AIDS. This is having a negative effect on the acceptance of grain amaranth amongst community members who adhere to this myth, as there is still much fear of anything associated with sickness, especially HIV.

This myth has been further extended to issues of fertility. In Amukura, there is a common belief amongst community members that if adult men eat grain amaranth they will become impotent. This links into the myth of grain amaranth as a crop only for those with HIV/AIDS – both myths involve sex. It is highly possible that due to people linking the crop to HIV/AIDS, there has also been the evolution of the myth that grain amaranth affects people sexually. One of the greatest fears and shames of an African male is lack of children or inability to reproduce. Thus, this myth which states that grain amaranth makes a man impotent is a very powerful idea that can seriously hinder the acceptance of the crop.

Meanwhile, in Mwatate, there is a common belief among community members that adult men who eat grain amaranth will be exceptionally virile. This is the opposite of the Amukura myth, yet is still a construction forged around issues of fertility and sex. Such a myth is an active promoter of grain amaranth within Mwatate, as men who seek the sexual prowess that grain amaranth can supposedly bestow are eager to grow and eat more of the grain. It is likely that this myth has also emerged from the emphasis afforded to promoting grain amaranth for people living with HIV. This emphasis has given rise to a myth that eating grain amaranth can be a way not only to prevent one from the negative sexual experience of contracting and living with HIV, but also a way towards increased virility.

At the fore of the promotion of grain amaranth for consumption has been the health/nutritional benefits that the grain provides. This has led to a variety of myths that are common in both Amukura and Mwatate. Possibly the most common myth espoused by community members is that grain amaranth can heal all kinds of diseases and

illnesses, including cancer, chronic bleeding, and even HIV. It is probable that these myths have emerged as a result of increasing community awareness and knowledge that incorporating grain amaranth into your diet is beneficial for your health and nutrition. However, this truth about grain amaranth has been extended to generate myths about the ability of grain amaranth to heal, cure, and prevent diseases. Although this myth is generating increased interest and acceptance of grain amaranth, there is a need for those people who are promoting grain amaranth to clarify what the grain can bring in terms of health benefits. It is highly likely that by incorporating grain amaranth into their diets, many people who are sick feel healthier, have more energy and reduced symptoms. However, the danger lies in when the benefits of grain amaranth are extended through myth, leading people to believe that they can be cured of something through grain amaranth alone. This may serve to lead sick people away from treatments that are essential in tackling their illnesses.

Other community myths have also emerged through an extension of facts that community members have heard about grain amaranth. One example is the fact that grain amaranth is extremely useful in tackling malnutrition, especially for children under five years of age. At the Amukura Orphanage, all children are fed grain amaranth porridge every day. Many other families are witnessing the beneficial effects of feeding their young children with grain amaranth daily. These beneficial effects have been extended into a community belief that not only will children who eat grain amaranth grow to be healthier but these children will grow bigger brains. There is no research study that shows that as a direct result of eating grain amaranth young children grow bigger brains. Therefore, the idea in Amukura and Mwatate that children who eat grain

amaranth will have bigger brains is not necessarily true. Yet, this is an example of a positive myth in which little harm may result in people believing that children will have bigger brains as a result of eating grain amaranth. In fact, this myth serves to encourage people to grow and eat grain amaranth, and in many ways it may improve brain function through the nutritional benefits with which grain amaranth supplies a person's body.

Another example of a positive myth that is an extension of the facts about grain amaranth is the practice of often exaggerating numbers linked to grain amaranth. For instance, it is common for people in both Amukura and Mwatate to speak of grain amaranth's nutritional benefits, especially its high protein content. So far, this is all fact. However, the truth once again gets extended when figures are quoted. Grain amaranth's protein content is frequently quoted as being at 60, 70, or even 80%. It is not known whether such exaggeration is due to misinformation given or misunderstanding on the part of community members, or whether it is due to a desire of community members who are advocates of grain amaranth to promote the crop to others in their community to whom protein content percentages may have little meaning. In reality, the protein content of grain amaranth is approximately 14%. However, stating that grain amaranth has a protein content of 80% sounds significantly more impressive than 14%. Thus, although such extensions of facts about grain amaranth could be misleading to community members, in essence such a myth in fact enhances the reputation, acceptance and adoption of grain amaranth in communities who are more concerned with the overall message about the crop and less concerned with the accuracy of numbers presented to them.

Community myths are thus central to the understanding of how and to what extent grain amaranth is being accepted in both Amukura and Mwatate. By appreciating community myths about grain amaranth, promotion of the crop within these communities can become even more effective and acceptance of grain amaranth will hopefully continue to increase.

Amaranth's role in a proper meal

The final socio-cultural influence that was highlighted by community members in both Amukura and Mwatate was the role of amaranth in what rural Kenyans considered to be a proper meal. Both communities have strong ideals as to what should be eaten for the main meal(s) of the day, and these ideals fit well with the theory of Mintz & Schlettwein-Gsell (2001), who proposed the Core-Fringe-Legume Hypothesis of meal composition to understand food patterns in rural societies such as found in Amukura and Mwatate. This theory proposed that meals in agrarian societies consist of three elements. First, the core is made up of a staple food, without which, the event cannot be considered to be a proper meal. The core is the focus of the meal, and most of the labor in terms of agricultural production and food preparation is devoted to this part of a meal. Secondly, the core is supplemented by the fringe, made up of a side-dish to provide flavor and taste. The fringe is not usually considered as an independent dish but is directly related to the core. Finally, the proper meal is likely to be completed with the inclusion of a legume to provide protein. However, this is the least essential element of the meal and therefore the most likely to be missing or get cut from a meal.

Key to the acceptance of amaranth is its role in a proper meal. Prior to grain amaranth promotion efforts, amaranth has occupied the fringe role, being used as a vegetable relish or sauce to supplement the main staple in rural Kenyan homes, *ugali*, a

type of sticky bread made from boiled maize, cassava, sorghum or millet flour. Promotion efforts are faced with the challenge of shifting amaranth's role from supplement to staple, from fringe to core. Grain amaranth as a food is being promoted as a flour that can be used to enhance the staple, by mixing grain amaranth flour with the predominant flour used to make *ugali*. Shifting the focus of amaranth's role from fringe to core requires a change in individual and community thinking about amaranth in general. This is where prior knowledge of amaranth as a vegetable could actually be an obstacle to the acceptance of grain amaranth, as habitual food choices concerning amaranth consider amaranth to be a fringe part of the meal, and therefore a fringe crop. However, this obstacle to acceptance is countered by the fact that households in both communities are accustomed to mixing flours from different staple crops to produce *ugali*. With promotion efforts focused on encouraging households to mix grain amaranth flour with other flours to produce *ugali*, the shift of thinking about amaranth from fringe to core is being achieved.

Biophysical Influences

Biophysical influences also impact individual and community acceptance of grain amaranth. The most important influence that falls under this category with respect to grain amaranth acceptance is that of taste. However, also important are other personal preferences, especially those that affect an individual's desire for his/her diet, such as the ideal of balanced nutrition and healthy food choices.

Taste

The taste of any foodstuff is highly influential upon acceptance by community members. Grain amaranth is no exception. Those community members in both Amukura and Mwatate who now produce and/or eat grain amaranth in their household

indicated the significance of taste in influencing their decision to accept grain amaranth. Although many different methods are used to promote grain amaranth adoption, many interviewees and focus group participants stressed the significance of cooking demonstrations and grain amaranth food tasting sessions. The response from these sessions is overwhelmingly positive, as many respondents testified to the fact that it was only when they finally tasted grain amaranth foodstuffs that they were convinced to seriously consider cultivating grain amaranth as a viable livelihood strategy.

The benefit of the food promotion efforts is highlighted in the vast array of food products in which grain amaranth can be used as an ingredient. Community members are encouraged to mix grain amaranth with other staples to complement and supplement their diets. For example, ugali, the traditional bread of these communities which is usually made with cassava or maize, can be made from a mixture of cassava or maize flour and grain amaranth flour at a ratio of 3:1 (1 part grain amaranth). A further benefit of the food promotion efforts is that by promoting grain amaranth to be not simply the sole ingredient of many traditional foods, but as a supplemental ingredient to boost nutrition, the need to continue to produce traditional crops such as cassava, maize, and finger millet has been encouraged. Thus, grain amaranth is being promoted as an additional crop and food ingredient, not as an alternative. This is resulting in a reinforcement of the existing livelihood system rather than an alteration of the system.

Other personal preferences

One of the central foci of grain amaranth promotion efforts has been to appeal to people's needs for healthy and nutritious foods. This has been especially important in the studied communities due to the high incidence of HIV/AIDS, but also due to the high

incidence of diseases such as malaria, typhoid, and tuberculosis. Grain amaranth is particularly high in protein which is generally difficult to get into rural Kenyan diets. The other main sources of protein are meat and other animal products which are expensive for many households to adopt them into their everyday diet, and legumes which are not as important to a meal as the staple *ugali*, and so are frequently missing or cut from meals.

Grain amaranth has therefore found a niche in communities where health and nutrition awareness has gone hand-in-hand with grain amaranth promotion. The acceptance of grain amaranth in Amukura and Mwatate has been enhanced by promotion efforts that have focused on the potential role of grain amaranth in providing nutritious food that can be incorporated as part of the staple in rural Kenyan diets. Both studied communities have a high rate of malnutrition and many poorer households are food insecure. Individuals and households that live in poverty and sickness have therefore been very open to accepting grain amaranth as a potential livelihood strategy option.

Economic Influences

In the studied communities, resource availability was limited. The vast majority of the diverse households interviewed were struggling for daily survival. Economic influences therefore also had an important impact upon individual and community acceptance of grain amaranth. These influences played out in two spheres – crop production and food preparation.

Crop production

Once individuals became aware of grain amaranth, economic influences assisted the acceptance of grain amaranth. The most significant influence was the fact that grain

amaranth requires few resources in order to produce a crop. One of the most promising features of grain amaranth production was that even in dry years, grain amaranth can be relied upon to produce a fair yield, unlike maize which is more susceptible to water stress. This was particularly important to households in Mwatate, where the climate is drier and rainfall tends to be more unreliable than Amukura. Grain amaranth also provides households with two opportunities – to produce multiple crops per year due to its short time to maturity, and to produce at times of year when other grains are unable to be cultivated. Grain amaranth's potential to help households fight off hunger due to these reasons has encouraged acceptance of the crop.

Food preparation

Grain amaranth also offers households economic advantages in its relatively short food preparation time in comparison with legumes, which are the other main reliable sources of protein in rural Kenyan diets. Grain amaranth is prepared in the same way as other grain crops, by grinding to flour, and then boiling to prepare an *ugali* made with a combination of grain amaranth flour and another flour, usually maize or cassava. Legumes such as beans, groundnuts, and green grams, which are commonly prepared in both Amukura and Mwatate, require a much longer preparation and cooking process before they are ready to be eaten. This factor has greatly enhanced the acceptability of grain amaranth among women, who occupy the principal role of preparing household food, and who are the ones who collect firewood for cooking. By incorporating grain amaranth into *ugali* as a reliable source of protein, time and money are both saved by a household. This is due to two factors. First, less fuel is needed for preparing *ugali* compared with legumes. Secondly, a household that replaces part of its legume

consumption with grain amaranth incorporation into *ugali* therefore requires a smaller amount of legumes to be produced and prepared.

Summary and Conclusion

This chapter has highlighted the importance of assessing acceptance of grain amaranth before analyzing the potential adoption of grain amaranth in Amukura and Mwatate. This acceptance rests on three spheres of influence – socio-cultural, biophysical, and economic – of which socio-cultural factors are the most critical in both communities. In general, both communities were accepting of grain amaranth, though Amukura residents were more accepting than Mwatate residents. This slight difference was mainly due to the issues highlighted under the topic of source of grain amaranth information, as well as due to a higher incidence of HIV in Amukura, which has led more people in that community to be on the search for practices to help them in their struggle with HIV.

This chapter has brought to the fore many important issues that help frame the analysis for the following chapters. In Chapter 6, the focus of this study builds on this assessment of grain amaranth acceptance, by looking at the potential adoption of grain amaranth in Amukura and Mwatate.

CHAPTER 6
THE POTENTIAL ADOPTION OF GRAIN AMARANTH BY DIVERSE HOUSEHOLDS IN AMUKURA AND MWATATE

Introduction

The introduction of grain amaranth as a new livelihood strategy option for households in rural Kenyan communities began ten years ago through an initiative spearheaded by CRWRC. Although in early years the initiative focused more on promoting the sale of grain amaranth for cash, focus is now distinctly upon promoting the consumption of grain amaranth as a strategy for breaking the vicious cycles of poverty, disease, and malnutrition. Feedback from rural communities indicated that initial adoption of grain amaranth by households has been sporadic. However, due to lack of time and resources, CRWRC has not conducted any formal evaluations to uncover which kinds of households are most likely to adopt grain amaranth in these rural communities.

Having identified and discussed the various factors affecting acceptance of grain amaranth and the resulting patterns of acceptance in both Amukura and Mwatate in Chapter 5, this chapter addresses Research Question 3 which assesses the potential adoption of grain amaranth by diverse households:

RQ3: For which kinds of household is grain amaranth production a feasible livelihood strategy option in these communities (Amukura and Mwatate)?

In order to answer this question, first a general discussion of overall factors affecting the adoption of grain amaranth in Amukura and Mwatate is presented. This discussion is based on the analysis of focus group feedback from participatory tools used in both communities. This discussion leads to the second and longer part of analysis in this chapter – the use of ELP to identify types of households in these

communities that have the greatest potential for adopting grain amaranth production as a livelihood strategy. Discussion of the ELP focuses on similarities and differences both between each community as a whole and among households within each community. This discussion assesses how the diversity of household compositions and allocated resources generates patterns of potential adoption of grain amaranth within these two communities.

Community-Wide Factors Affecting Potential Adoption of Grain Amaranth

In both Amukura and Mwatate, semi-structured interviews with individual households and focus group discussions using participatory tools revealed a wide range of reasons both for and against adopting grain amaranth as a livelihood strategy option. These reasons included environmental issues, economic concerns, and health and nutrition matters concerning grain amaranth.

Table 6-1. Main factors affecting potential adoption of grain amaranth in Amukura and Mwatate identified by individual interviews and focus groups

Criteria	Amukura	Mwatate
Nutrition/health benefits	Widely known	Widely known
HIV/AIDS	Pervasive but improving	Pervasive
Agronomic know-how	Lacking	Lacking
Market opportunities	Limited but expanding	Limited
Number of potential seasons	Three	Two
Available land	Extremely limited	Abundant, yet good agricultural land in short supply
Available cash	Limited	Limited
Seed	Available	Difficult to get
Price of grain	35-40Kshs/kg	45-50Kshs/kg
Maintaining seed quality	Out-crossing with wild species	Old seed with declining viability
Pests/diseases	Negligible	Significant
Soils	Varied	Predominantly Alfisols
Rainfall	Waterlogging in wet years	Generally adequate

Synopses of the factors affecting potential adoption of grain amaranth and the comparison between the two communities are given in Table 6-1. The potential benefits and problems of grain amaranth production that were identified both in individual household interviews and focus group discussions varied significantly between Amukura and Mwatate. Therefore, these divisions will be addressed in turn.

Amukura

Perceived benefits of grain amaranth production

Community members who had already adopted grain amaranth as a household livelihood strategy were in general extremely positive about the crop. There were limited instances of people who had grown grain amaranth but had since abandoned this livelihood strategy – the majority of those who had begun to cultivate grain amaranth were continuing to do so. These people identified a number of different reasons as to why they had adopted grain amaranth as a household livelihood activity and why they were continuing to produce grain amaranth.

The most frequent reasons cited were health, food and nutrition security benefits. The promotion efforts have highlighted the nutritional composition of grain amaranth that is complementary to other grains commonly found in people's diets in Amukura. Most community members were aware of the nutritional benefits of eating grain amaranth and gave testimony to the increased strength that they received after eating grain amaranth in comparison to eating other grains. Many community members were also affected by HIV/AIDS – some were living with HIV themselves; or someone in their household had HIV/AIDS; or they had family, friends or neighbors who had HIV/AIDS. Therefore, the impact of grain amaranth on HIV/AIDS was of utmost importance to this community. Many people highlighted the boost to the immune system and the relief

from HIV symptoms that consuming grain amaranth regularly can provide. They also indicated that regular grain amaranth consumption (in a variety of foods) helped to alleviate symptoms of other diseases and chronic conditions. In addition, many noted that regular grain amaranth consumption by young children (especially those under the age of five years) was reducing incidence and severity of malnutrition in the division, which was commonplace amongst that age group.

In addition to health and nutritional benefits, community members were well aware that grain amaranth production had environmental advantages. Grain amaranth reaches maturity in no more than 75 days in Kenya, and many households noted that this short season length enabled them to get in multiple (up to three) crops of grain amaranth per year. The ability to produce multiple crops of grain amaranth was enhanced by the abundance of rainfall throughout approximately 7-8 months per year. Even when rainfall was in short supply, community members already growing grain amaranth highlighted the drought resistant qualities of the crop, and that reliable yields could still be expected even in dry years. For this reason, they argued, grain amaranth was increasing the food security of their households.

Another environmental benefit of producing grain amaranth in Amukura was the variety of soil types that provided different environments in which grain amaranth could be tried and tested. This was particularly important as grain amaranth is a heavy feeder, especially of nitrogen, and so requires soils with good fertility. However, continual production of grain amaranth on fertile soils without the addition of nitrogen fertilization can quickly lead to deterioration of the soil. Therefore, rotation policies with grain amaranth still need to be considered for soils to maintain fertility. In addition, the

absence of pest and disease pressure indicated that Amukura was a favorable environment for grain amaranth to be established. Grain amaranth does not suffer readily from problems such as *Striga* spp., which can decimate maize and sorghum yields in particular, nor does it suffer significant pest problems mainly due to its relatively short time between planting and harvest.

Grain amaranth seed was also readily available to the majority of households. Most people interviewed were aware of where they could obtain grain amaranth seed. There were several instances of emerging farmer networks based around grain amaranth production, which would be valuable sources of community amaranth seed.

Grain amaranth in Amukura also promised economic benefits to those producing the crop. Although market opportunities were still limited, many households were actively seeking new markets, and claimed that grain amaranth could fetch a lucrative price for the yields that are produced. Households already producing grain amaranth also indicated that the market value of their animals had increased when they fed these animals amaranth products. For example, chickens were often allowed to forage through grain amaranth chaff, while cattle were fed amaranth stalks after the grain had been harvested.

Perceived obstacles to grain amaranth production

Discussions with individual households and community groups who had never grown grain amaranth revealed that there were still many obstacles to widespread adoption of grain amaranth in Amukura. Some of these obstacles are easier to tackle than others – some are in the realm of possibility for amaranth promoters to overcome, whilst others are more structural constraints that are much more difficult to get around. The most often cited problems were that most people had very little knowledge about

grain amaranth and anything related to the crop. Lack of information about grain amaranth included how to find seed, how to cultivate the crop, how long the crop takes to mature, and the importance of the crop in terms of food and nutrition security. Although these were the problems that most people identified first, these issues were addressed by the Amukura CDF with any household or focus group that wanted to know more about grain amaranth.

Another obstacle that was frequently mentioned was that many households were affected by HIV/AIDS to such an extent that the household members were either too sick to learn about a new crop or were so overwhelmed that they had little time to devote to a new and/or different livelihood activity. However, this problem was starting to be overcome, especially through the establishment of an AMPATH (Academic Model for the Prevention and Treatment of HIV/AIDS) clinic at Amukura health center. AMPATH was introduced to Amukura in 2003 as a joint venture by the University of Indiana Medical School and Moi University of Eldoret. AMPATH delivers holistic treatment and prevention services in 19 hospitals and rural health centers across Western Kenya administered by the Kenyan Ministry of Health. AMPATH provides free HIV testing to anyone, and for those who test positive for HIV, AMPATH provides free ARV (anti-retroviral) drugs. AMPATH also works in conjunction with the World Food Programme (WFP) to provide food assistance to people living with HIV. Anyone who is tested positive for HIV is entitled to 6 months of free food supplies from AMPATH/WFP to help the household to cope through the symptomatic phase of initial HIV infection. It is currently estimated that AMPATH delivers care to more than 55,000 people, in the form of HAART (highly active antiretroviral therapy), community mobilization, food

distribution and harvest initiatives to secure food, family preservation initiatives to secure income, and counseling and support groups (Academic Model for the Prevention and Treatment of HIV/AIDS 2007). In Amukura, there is a regular bi-weekly group meeting at the AMPATH clinic for anyone living with HIV. At this meeting, people living with HIV support and encourage one another, and grain amaranth promotion is one of the ways in which they are encouraging others affected by HIV.

Some of the more structural constraints that are proving more difficult to overcome are environmental and economic issues. Many households mentioned that they were already land constrained and so were not enticed at the prospect of an additional livelihood strategy, no matter the benefits growing grain amaranth may promise. In order for many households to adopt grain amaranth, they would have to give up on other livelihood strategies which are often culturally ingrained. The intercropping of grain amaranth was uncommon due to cultural practices in grain amaranth production. For example, when weeding grain amaranth with a traditional hoe (*jembe*), farmers prefer to have direct access to the area surrounding grain amaranth plants in order to complete a thorough weeding. This leaves little available field space to cultivate another crop alongside grain amaranth in the same field. Furthermore, most households were below the poverty line and therefore lacked economic resources for initial purchases of grain amaranth seeds, bags for harvest, fertilizers for high yields, and other inputs. This lack of cash was particularly significant for the adoption of a new activity as much of a household's cash was often already consigned to ongoing activities that were familiar investments to households.

Other additional constraints were predominantly environmental. Many people noted problems with waterlogging of amaranth stands in particularly wet years which resulted in reduced harvests. This would occur during times of especially intense and prolonged rains in which all fields are susceptible to waterlogging. Furthermore, the existence of many different wild varieties of amaranth that are native to the area caused difficulty in maintaining pure seed of grain species of amaranth due to frequent out-crossing. These wild varieties tend to have black seeds, whereas the grain species have white, cream, or yellow seeds, and seed stocks saved for the following season's planting can easily become mixed. Further seed problems include the decline in productivity of saved grain amaranth seed due to reductions in seed viability and inability to protect stored grain amaranth seed from mold. Seed was therefore typically purchased by households rather than saved from season to season in order to ensure good seed quality.

Mwatate

Perceived benefits of grain amaranth production

Community members in Mwatate who had already adopted grain amaranth as a livelihood strategy focused on similar benefits of grain amaranth production to those noted by Amukura residents. The most often cited reasons for producing grain amaranth were health, food and nutrition security benefits. Many people in Mwatate were also living with HIV or had someone in their household living with HIV. The importance of regular consumption of grain amaranth was of top priority for many of those who had already adopted grain amaranth as a livelihood strategy. These people proposed that this was because grain amaranth helped boost the immune system, which is directly affected by HIV. In addition, the health benefits noted included grain

amaranth's ability to provide all people, not only those living with HIV, increased amounts of energy, as well as its ability to help give strength to those fighting disease. In particular, many noted the decline in childhood malnutrition that was occurring in households that were growing and utilizing grain amaranth. Grain amaranth was also commonly used as a local medicine for specific sicknesses, especially stomach problems. Many people also noted that grain amaranth is highly nutritious, rich in protein, and good for your teeth, presumably from hearing that amaranth is high in calcium.

Many people who were already producing the crop argued that grain amaranth could also bring significant economic returns to Mwatate households. The price per kg was approximately 10Kshs higher in Mwatate than in Amukura, which probably reflected the lower level of production of grain amaranth currently in Mwatate compared with Amukura. Those who could find a market to sell their product were able to reap significant cash income in an area where cash flow is low as economic prospects are limited. However, finding a regional market was often a significant constraint that resulted in limiting farmers' interest in grain amaranth production.

Grain amaranth also responds well to the favorable conditions of Mwatate's rainy seasons, if rains are sufficient to stimulate growth of amaranth plants in the first 21 days after planting. Timing of grain amaranth planting is therefore important, especially as Mwatate is more susceptible to drought than Amukura. High yields can be obtained if fertilizer or manure is applied to the crop at the time of planting, and many people noted that grain amaranth required fewer labor days than other grain crops.

Perceived obstacles to grain amaranth production

Despite the range of benefits to grain amaranth production in Mwatate, there were significantly more obstacles than benefits to grain amaranth production in Mwatate. There also appeared to be more obstacles to grain amaranth production in Mwatate compared with Amukura. Obstacles, like benefits, were varied and ranged from environmental to economic to socio-cultural. Environmental obstacles in Mwatate were more than are first apparent. Mwatate seems to have an ideal climate for grain amaranth, with low to medium amounts of annual rainfall, and a bimodal rainfall pattern. However, when Mwatate community members were asked what their biggest problem with grain amaranth cultivation was, the majority of people said that there was not enough rain. Increasing frequency of drought in the Mwatate area combined with erratic and unreliable rainfall patterns often made attempts to produce grain amaranth fail. Many people indicated that they would plant their seed after a good rain, but then often little or no more rain would come, and the seed would be wasted. In addition, the soils in Mwatate are typically Alfisols and compaction of the soils through continual wetting and drying can be a significant problem. This can make land preparation laborious and compaction itself can potentially hinder germination.

Grain amaranth in Mwatate was also subject to a significant number of pest problems, which were not mentioned in Amukura. One major problem was red ants that carry away the seeds right after planting. Other problems included a stalk borer which affected the growth of amaranth plants as well as an unidentified insect pest that fed on the inflorescences as the amaranth plants were setting their grain. Community members and the local partner organization were struggling with how to deal with these pests.

Another problem in Mwatate was the issue of seed. Although households in Mwatate did not have a major problem with outcrossing, they were receiving declining grain amaranth yields due to lack of a source of new grain amaranth seed. Pwani-CCS, the local partner organization, even noted that the grain amaranth seed they had was five years old and was obtained from Kenya's Western Region. The prospects for grain amaranth production to increase depend to an extent on local seed bulking efforts to provide a local source of grain amaranth seed.

Further constraints to grain amaranth production in Mwatate that were frequently mentioned by community members included lack of fertilizers or manure to assure high yields, high labor demands at harvest time, and lack of traditional farm implements that often had to be shared between household members. Lack of available land was also commonly cited as a problem. Although most households have several acres of agricultural land, much of this land is of low soil fertility, and is used predominantly for grazing. There is a significant lack of high fertility land, and such good-quality land that is available is usually very costly to rent, as well as having a high opportunity coast for other crops.

All these limitations were discouraging farmers from attempting to plant grain amaranth. Unfortunately, as a critical mass of people in Mwatate become discouraged about grain amaranth, it becomes increasingly difficult to remobilize grain amaranth promotion efforts. Significant change in the promotion efforts is needed in order to overcome not only the constraints themselves, but also the perceived increasing magnitude of the constraints in the eyes of many Mwatate residents.

Modeling the Introduction of Grain Amaranth as a Livelihood Strategy Option for Diverse Households in Amukura and Mwatate

Discussion and analysis of the various perceived benefits and obstacles to grain amaranth production in Amukura and Mwatate has provided the context to Research Question 3. However, in order to answer this research question more directly and completely, analysis of the diverse households in these communities must be conducted to uncover which kinds of household have the potential to adopt grain amaranth production as a livelihood strategy and which kinds of households lack this same potential. In addition, it is important to understand the reasons behind the different levels of potential adoption among households within the same community and between communities. In order to conduct this analysis, the 'BASIC' ELP used to model diverse households in Chapter 4 was used as the framework for the generation of the 'AMAR' ELP to model these same households in the context of the introduction of grain amaranth into their livelihood system.

The AMAR ELP was exactly the same as the BASIC ELP except for the inclusion of grain amaranth production for household consumption and/or sale as an additional livelihood strategy option. In Amukura, grain amaranth production was a livelihood strategy option for Feb-Apr, May-Jul, and Aug-Oct (three seasons). On the other hand, in Mwatate, grain amaranth production was an option for Feb-Apr and Aug-Oct only (two seasons). This difference reflected the possibility of producing grain amaranth in the short dry season in Amukura, which was not possible in Mwatate. Grain amaranth yields were poorer in the May-Jul season than the other two seasons in Amukura, and this was incorporated into the model. The assumptions in the AMAR ELP were exactly the same as for the BASIC ELP with the exception that all households started in year 1

of the model with the same amount of available cash they started with under the BASIC scenario.

In this section, the model results for the diverse households are analyzed for each community in turn, first for Amukura, then for Mwatate. Attention is given to assessing which types of households adopt grain amaranth production, whether these households adopt grain amaranth for home consumption, sale or both, and when (seasons and years) grain amaranth is adopted. Attention is also given to understanding why other households in both communities lack the potential for adoption of grain amaranth production. Furthermore, focus is given to the impacts on livelihood strategy choices for all households under the AMAR scenario – i.e. when the potential for adoption of grain amaranth production is introduced. These impacts are analyzed through assessing the changes in household diet and household market sales for those that adopt grain amaranth production. Emphasis is also given to comparing the potential adoption of grain amaranth production between households in Amukura and those in Mwatate.

Amukura

Adoption of grain amaranth for household consumption

Nine of the 16 diverse Amukura households adopted grain amaranth for consumption under the AMAR scenario (Table 6-2). Five of these nine households (6, 7, 10, 15 and 16) were already meeting minimum consumption requirements under the BASIC scenario. Therefore, these five households adopted grain amaranth production for consumption due to its comparative advantages over other foods, and not simply to help these households meet consumption needs. Out of these five, household 7 consumed the most grain amaranth. This was due to two reasons. First, household 7 had a balanced household composition in terms of the ratio of male to female labor,

which provided favorable conditions for this household to adopt grain amaranth production. Secondly, more than 80% of the total amount of grain amaranth that household 7 consumes is eaten between years 5 and 7. This is the only period of time in which household 7 has six mouths to feed rather than five, and three youths rather than two. In other words, the time of greatest stress upon household 7 is between years 5 and 7 – the time of highest grain amaranth consumption. This is because when this household was under stress, protein consumption was the first consumption requirement to not be met. Grain amaranth was therefore adopted by this household during years 5 through 7 for consumption to help meet minimum protein requirements.

Table 6-2. Total consumption of grain amaranth (bags) for years 2-10 for Amukura households

Household [1] (composition in years 1-4) [2]	Year 2	3	4	5	6	7	8	9	10	Total
5 (1-1-0-0-2)	2.87	4.09	2.85	0.93	0	0.27	0	1.26	0	12.26
6 (1-1-3-3-1)	0	2.31	1.87	4.43	0	0	0	0	0	8.62
7 (1-1-1-1-1)	0.93	1.54	0	5.04	3.48	4.11	0	0	0	15.09
8 (1-1-1-0-2)	4.04	3.69	1.68	5.45	3.10	5.52	0	0	0	23.49
10 (2-3-3-2-0)	0	0	0	3.26	0	0	0	0	0	3.26
12 (1-1-2-2-4)	2.79	0	0	0.06	0	0	0	0	0	2.86
13 (2-1-1-0-1)	7.15	4.31	4.32	0	0	0	0	0	0	15.77
15 (1-1-0-0-1)	0.37	0	0	0	0	0	0	0	0	0.37
16 (1-1-0-1-1)	0	0	0	1.31	0	1.09	0	0	0	2.40

The consuming of grain amaranth at periods of greatest stress particularly due to struggles to meet minimum protein requirements because of changes in household composition is not unique to household 7. In fact, this is the most crucial factor underlying the adoption of grain amaranth for consumption by Amukura households.

[1] See Table 4-3 for the changes in Amukura household compositions for years 5-8 and 9-11.

[2] Household compositions in the format of numbers of (male adult – female adult – male youth – female youth – child)

The other four households (6, 10, 15 and 16) that already met minimum consumption requirements under the BASIC scenario also adopted grain amaranth at the times of household stress due to changes in household composition. Household 6 consumed grain amaranth when there were a large number of youths in the household; household 10 only consumed grain amaranth in year 5 immediately after a female adult left the household; household 15 only consumed grain amaranth in year 2 when the household had no youths to help supply labor; household 16 only consumed grain amaranth in years 5 and 7 when it was adjusting to cope with an extra mouth to feed.

The other four households (5, 8, 12 and 13) that adopted grain amaranth for consumption were ones that had to reduce consumption under the BASIC scenario. Therefore, these households were already under stress, and the adoption of grain amaranth production for consumption was a livelihood strategy decision that enabled these households to relieve some of this stress. Households 5, 8 and 13 were three of the four biggest consumers of grain amaranth. Under the AMAR scenario, these households incorporated grain amaranth as part of their household diet and increased their intake of calories and/or protein (Table 6-3).

However, two of the six households (households 3 and 4) that were food insecure did not adopt grain amaranth for consumption, yet were still able to increase their overall household consumption (Table 6-3). Instead of directly including grain amaranth in their household diet, households 3 and 4 increased their consumption through the sale of grain amaranth to generate cash for purchasing other high-protein foods to consume. These two households did not adopt grain amaranth production for consumption as these were both FHH which had limited male labor. A balance of male

and female labor is necessary for grain amaranth production, so these FHH stuck with producing legumes as the main source of protein and other grains as the main sources of calories for their households.

Table 6-3. Amukura households' change in calorie/protein consumption by time period under the AMAR scenario compared with the BASIC scenario

Household (composition in years 1-4)	Percentage reduction from minimum requirements under AMAR scenario						Percentage improvement under AMAR scenario compared with BASIC scenario					
	Calories			Protein			Calories			Protein		
	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10
3 (0-1-1-1-3)	23	0	0	30	0	0	1	0	0	0	10	0
4 (0-1-0-0-2)	0	0	0	0	0	0	0	0	0	5	0	0
5 (1-1-0-0-2)	0	0	0	0	0	0	1	0	0	18	0	0
8 (1-1-1-0-2)	17	0	0	24	2	0	9	11	0	16	28	0
12 (1-1-2-2-4)	29	0	0	40	10	10	-1	0	0	0	0	10
13 (2-1-1-0-1)	13	0	0	20	10	0	-3	0	0	10	0	0

Out of these six, only households 4 and 5 were able to remove all consumption reductions and meet minimum household consumption requirements. Household 4 was already experiencing only a 5% shortfall in protein in years 2-4, which was met by purchasing extra legumes with the cash generated from grain amaranth sales in those years. Meanwhile, household 5 had an 18% shortfall in protein, which was met by consuming grain amaranth.

The biggest improvement in household food security was for household 8. This household was the worst off in terms of consumption reductions under the BASIC scenario. However, by adopting grain amaranth for consumption, household 8 was able to increase both calorie and protein intake – the only household to do so significantly. The other five households were able to significantly increase their protein intake under the AMAR scenario, but showed little change in their calorie intake. However, households 3, 12, and 13 did not increase their consumption as much as household 8.

Household composition differences are crucial in understanding these differences in increase in consumption. Households 3 and 12 continued to be constrained by the large number of small children in their households. On the other hand, households 8 and 13 had similar compositions in that they had plentiful male labor and yet were constrained by their short supply of female labor. In these households, female labor was switched from other labor-intensive protein-producing activities (such as legume production) to grain amaranth production, which was less labor-intensive yet still generated high-protein food for household consumption. However, the female labor constraint still prevented households 8 and 13 from increasing their consumption to meet the minimum consumption requirements. Households 8 and 13 thus have similar reductions in calorie and protein intake under the AMAR scenario. Household 8 increased consumption more than household 13 because household 8 consumed more grain amaranth (Table 6-2) and it was worse off in terms of consumption reductions under the BASIC scenario, and so had more scope for improvement.

Grain amaranth production for consumption can therefore help to stave off the threat of undernourishment facing Amukura households that are unable to meet minimum consumption requirements. Grain amaranth is also consumed by households that met all their consumption requirements at times when these households are experiencing some form of stress. Grain amaranth was adopted by all these households for consumption due to its comparative advantages over other crops in providing a high-protein crop in a short amount of time. Protein was the main limiting consumption factor and available labor was a key constraint for all Amukura households under the BASIC scenario. Therefore with the introduction of amaranth, households were able to increase

their food security either throughout the period of the model or just in times of stress through directly incorporating grain amaranth into their diet or through selling grain amaranth for cash to buy other high-protein foods for consumption.

Seven of the 16 households modeled in Amukura did not adopt grain amaranth production for consumption. There was not enough of an incentive in the level of protein and calories that grain amaranth could provide for these households to adopt it as a livelihood strategy. All four FHH fell into this category. These FHH continued to focus production for consumption on legumes and other grains as under the BASIC scenario. These households lacked the necessary balance in ratio of male to female labor to make grain amaranth production for consumption a useful strategy to adopt.

Of the three other households (9, 11 and 14) that did not adopt grain amaranth production for consumption, households 9 and 14 had plentiful female labor and available cash which enabled them to produce enough legumes to meet minimum protein requirements. Meanwhile, household 11 was constrained by land and lack of available initial cash to invest in a new production activity. In addition, grain amaranth yields were not high enough to help meet this household's minimum consumption requirements. These three households (9, 11 and 14) therefore continued to consume the same foods as under the BASIC scenario.

Annual and seasonal variation in grain amaranth consumption

Grain amaranth adoption not only varied between households in Amukura but also varied across time within each household that adopted it. This variation occurred both across the years and among the three seasons modeled – these will be addressed in turn.

As previously discussed, the adoption of grain amaranth production for consumption by households occurred during periods of greatest stress on these households due to changes in household composition. These changes in stress varied among households, such as an adult leaving the household, the birth of more children, or the changes in the gender composition of the household. This links directly to another crucial factor affecting the adoption of grain amaranth production for consumption – as household end year cash increased, grain amaranth consumption declined. As the objective function of these models was to maximize end cash in year 11, the end year cash of the majority of Amukura households increased over time depending on changes in household composition. Therefore, as the years went by, less grain amaranth was consumed by Amukura households because they were more cash secure, which in turn led to increased food security. As households generated more cash, they could afford to produce or purchase foods other than grain amaranth which were either higher in protein (most legumes) or higher in calories (most other grains). Therefore, in years 8 to 10, household 5 was the only one to produce grain amaranth for consumption (Table 6-2). All other households had abandoned producing grain amaranth for consumption in favor of other livelihood strategies because they were no longer under food or financial stress. This suggests that grain amaranth has an important role in households under stress, but does not have enough incentives for widespread production by households not under stress. It is important to note, however, that most households in rural Kenyan communities are under some form of stress the majority of the time, thus encouraging the potential adoption of grain amaranth.

There was also seasonal variation of grain amaranth consumption among those households that adopted it (Table 6-4). All nine households consumed grain amaranth in the Aug-Oct season, whereas only seven of the households consumed grain amaranth in the other two seasons. This difference occurred despite labor being constrained in all three seasons for the majority of households. However, as amaranth seed (3500Kshs per kg) was more expensive than other grain seed (maize 1250Kshs per kg; sorghum 1400shs per kg; finger millet 1500Kshs per kg), households could not afford to purchase as much grain amaranth seed to plant in earlier seasons compared with the Aug-Oct season. This was because the earlier seasons followed directly after households had spent end year cash on household necessities and school fees. Therefore, households generally had less cash in February than they did in August. By August, households had more cash with which they could purchase grain amaranth seed.

Table 6-4. Seasonal variation in grain amaranth consumption (total bags consumed years 2-10)

Household (composition in years 1-4)	Feb-Apr	May-Jul	Aug-Oct
5 (1-1-0-0-2)	2.41	2.22	7.63
6 (1-1-3-3-1)	3.07	3.12	2.42
7 (1-1-1-1-1)	5.62	1.05	8.42
8 (1-1-1-0-2)	9.10	6.36	8.02
10 (2-3-3-2-0)	0	0	3.26
12 (1-1-2-2-4)	0.04	0.02	2.79
13 (2-1-1-0-1)	4.46	3.71	7.60
15 (1-1-0-0-1)	0	0	0.37
16 (1-1-0-1-1)	0.29	2.06	0.06

The least amount of grain amaranth was consumed after the May-Jul season for all households except households 6 and 16. This was because this season had the least reliable rainfall and so produced lower yields of grain amaranth than the other

seasons. However, for households 6 and 16 this season represented a chance to get in an extra crop to help their households through times of stress. They were both able to produce grain amaranth for consumption during this season because they had the necessary additional labor to meet the production demands of grain amaranth while also harvesting other crops from the first season.

Adoption of grain amaranth for sale

Grain amaranth was also adopted by Amukura households for sale. Households that sold grain amaranth fell into two categories – those that sold surplus grain amaranth that they did not consume, and those that sold grain amaranth but did not consume any. Therefore, although the adoption of grain amaranth for sale is discussed here in a separate section, it should be understood that in many cases the sale of grain amaranth is inextricably linked to household grain amaranth consumption.

Table 6-5. Total sales (bags) of grain amaranth by Amukura households (years 2-10)

Household (composition in years 1-4)	Total bags sold
1 (0-2-2-3-1)	4.58
2 (0-1-0-2-1)	0.02
3 (0-1-1-1-3)	7.37
4 (0-1-0-0-2)	5.07
5 (1-1-0-0-2)	19.99
6 (1-1-3-3-1)	34.22
7 (1-1-1-1-1)	12.24
8 (1-1-1-0-2)	54.19
9 (1-2-1-1-2)	0
10 (2-3-3-2-0)	5.07
11 (1-1-0-0-0)	4.71
12 (1-1-2-2-4)	45.85
13 (2-1-1-0-1)	48.51
14 (1-3-0-2-3)	0
15 (1-1-0-0-1)	4.57
16 (1-1-0-1-1)	2.15

All households in Amukura sold grain amaranth under the AMAR scenario except for households 9 and 14 (Table 6-5). Both these households were polygamous households with plenty of female labor but a short supply of male labor. As grain amaranth production requires a balance of male and female labor, this activity was not adopted by these households due to their unbalanced supply of labor by gender. Instead households 9 and 14 remained focused on selling the surplus of other food crops that were more reliant on female labor, such as beans. The other two households (1 and 10) with more than one adult female produced only small amounts of grain amaranth for sale, confirming that households with abundant adult female labor were not enticed to adopt grain amaranth as a livelihood strategy to the same extent as many of the other Amukura households.

Households that already produced grain amaranth for consumption were the most likely to sell grain amaranth, as they had already invested land, labor and cash into grain amaranth production. The sale of surplus from their production was therefore a logical step for these households in order to generate cash, rather than spending valuable resources on a different livelihood activity to generate cash. Households 8, 12 and 13 were the biggest sellers of grain amaranth (Table 6-5). These households were also the ones that faced the biggest consumption reductions under the BASIC scenario. Selling grain amaranth from surplus production was thus adopted the most by households that were facing the biggest challenges to food security.

Three households (3, 6 and 12) in Amukura were unable to send all their youths to school under the BASIC scenario. Although all three households sold grain amaranth under the AMAR scenario, only household 6 was able to generate enough cash to put

one youth back in school in years 8-10. This was because households 3 and 12 used the cash generated from grain amaranth sales to help them increase their overall household consumption, whereas household 6 was not facing any consumption reductions under the BASIC scenario. Household 6 was also the fourth highest grain amaranth selling household (Table 6-5). This suggests that households that were facing challenges with meeting minimum cash requirements were also adopting the production of large quantities of grain amaranth for sale.

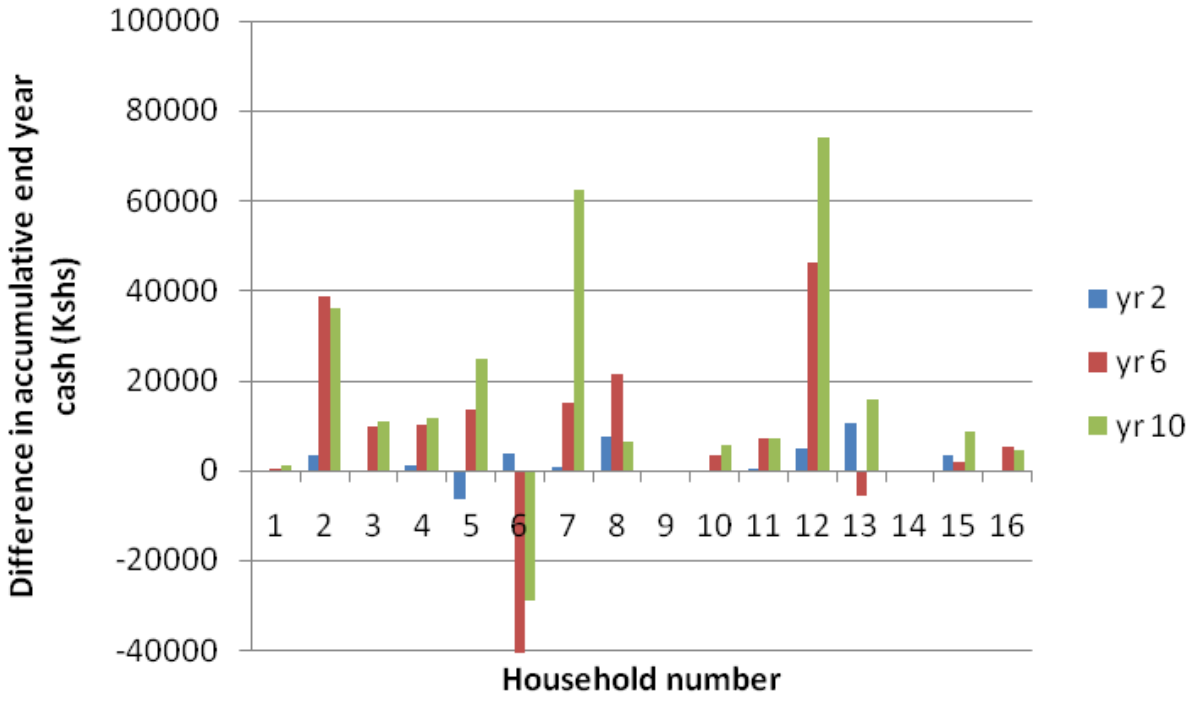

Figure 6-1. Change in Amukura households' accumulative end cash (years 2, 6 and 10) from the BASIC to the AMAR scenario

Furthermore, households 7 and 12 – two of the households with the lowest end year cash in year 10 under the BASIC scenario – generated the largest absolute increases in accumulative end cash by year 10 under the AMAR scenario (Figure 6-1). Households 2, 3 and 4 were also able to generate significant additional end year cash,

indicating that the introduction of grain amaranth enabled these FHH to become more financially stable. These households were able to generate this additional cash not only through the sale of grain amaranth but also through using the cash generated from selling grain amaranth for other livelihood activities that could in turn generate even greater returns on their investment. All households that sold grain amaranth were able to increase end cash in year 10 except for household 6, which, by sending an extra youth to school for three years, had invested extra cash through school fee payments.

Annual and seasonal variation in grain amaranth sales

There is significant variation in both annual and seasonal grain amaranth sales by Amukura households. In terms of annual variation, the highest grain amaranth sales occurred between years 2 and 4 for ten of the fourteen households that sold it (Figure 6-2). This concurred with the finding from the analysis of grain amaranth consumption – grain amaranth was most often sold when households were struggling in early years with low end year cash. The adoption of grain amaranth provided these households with the opportunity to quickly increase end cash levels through the production of a crop in three potential seasons with a high cash return on initial investment. Due to the high relative cost of grain amaranth seed to seed of other grain crops, however, these households needed to invest a significant amount of initial cash to start grain amaranth production. Thus, even if these households were struggling with low end year cash, they still had enough to invest in grain amaranth production.

The other four households (7, 10, 11 and 16) sold the most grain amaranth between years 5 and 7 (Figure 6-2). This corresponded with the times when these households had higher end year minimum cash requirements due to larger household sizes and more school fees to pay for youths. Grain amaranth sales were at their lowest

between years 8 and 10 for all households except 7 and 10 (Figure 6-2). These households had balanced household gender compositions and so were able to maintain sales at a steady rate over time. However, sales by these households in these years were not large compared with sales by other households during other time periods.

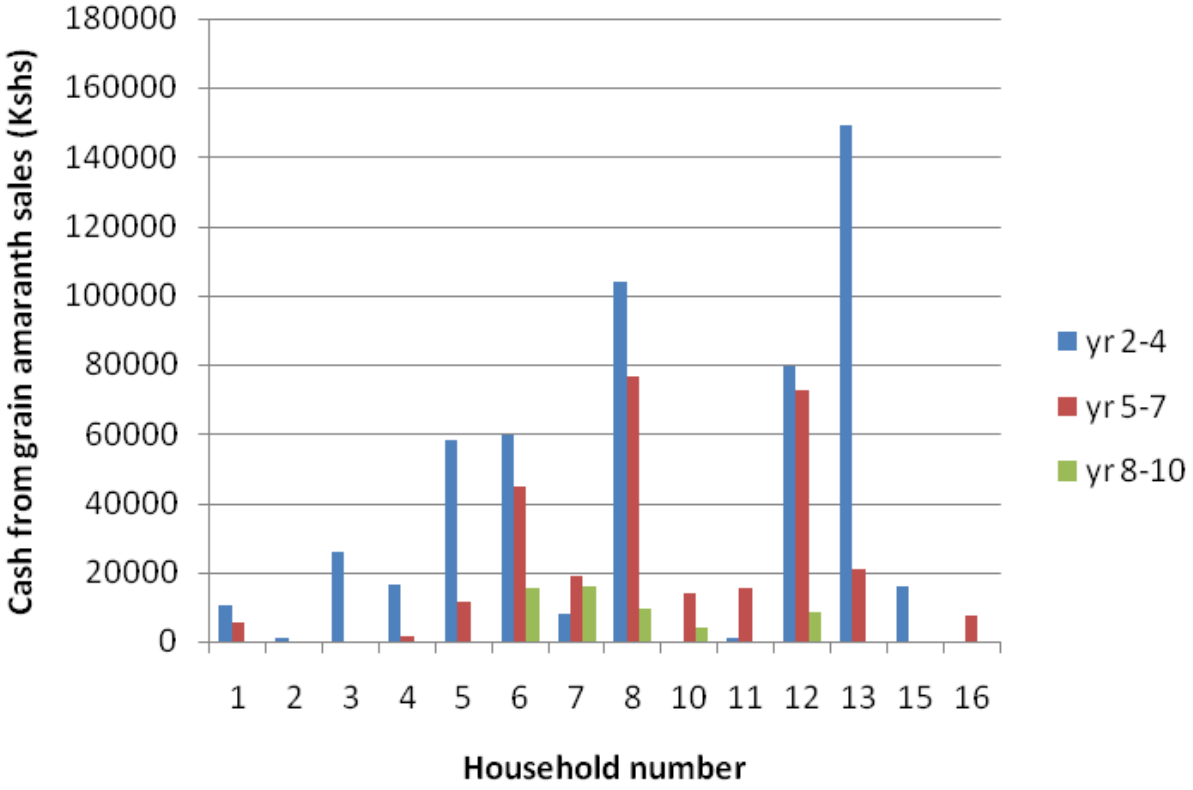

Figure 6-2. Variations over time in the sale of grain amaranth by Amukura households

Therefore, grain amaranth sales decline with improvement in household end cash. As households become more financially secure, they turn from producing grain amaranth for sale to alternative livelihood strategies as discussed in the following two sections. The production of grain amaranth for sale thus has the highest potential for adoption by Amukura households during times of stress.

In terms of seasonal variation, findings were both similar and different from the seasonal variation in grain amaranth consumption. Similar to the seasonal variation in

grain amaranth consumption, the season with the lowest sales of grain amaranth was May-July due to the poorer yields of grain amaranth in this season. Meanwhile, the main difference between consumption and sales by season was that February-April (first) season grain amaranth sales were higher or equal to sales in any other season for every household (Table 6-6), while August-October (second) season grain amaranth production for consumption was higher than for any other season. The drive to sell more grain amaranth in the first season of the year reflected the desire of households to generate more cash earlier in the year to be able to invest in other activities later in the year. For those households that sold the most grain amaranth (6, 8, 12 and 13), sales in the first season were approximately double sales in the second season, which was the next most important season for sales.

Table 6-6. Seasonal sales of grain amaranth by Amukura households (total bags sold years 2-10)

Household (composition in years 1-4)	Feb-Apr	May-Jul	Aug-Oct
1 (0-2-2-3-1)	3.84	0	0.75
2 (0-1-0-2-1)	0.02	0	0
3 (0-1-1-1-3)	4.79	2.43	0.15
4 (0-1-0-0-2)	2.75	1.56	0.76
5 (1-1-0-0-2)	12.90	3.12	3.97
6 (1-1-3-3-1)	20.03	3.45	10.73
7 (1-1-1-1-1)	6.47	2.52	3.25
8 (1-1-1-0-2)	36.47	2.55	15.17
9 (1-2-1-1-2)	0	0	0
10 (2-3-3-2-0)	2.54	0	2.54
11 (1-1-0-0-0)	2.36	0	2.35
12 (1-1-2-2-4)	30.22	0	15.62
13 (2-1-1-0-1)	29.29	7.98	11.24
14 (1-3-0-2-3)	0	0	0
15 (1-1-0-0-1)	2.29	0	2.29
16 (1-1-0-1-1)	1.07	0	1.07

Impacts of grain amaranth adoption upon household diets

The adoption of grain amaranth as a livelihood strategy option for consumption and/or sale had significant impacts upon Amukura household diets. There were greater impacts on the diets of the six households (3, 4, 5, 8, 12 and 13) that had failed to meet minimum consumption requirements under the BASIC scenario as all of these households were able to increase consumption under the AMAR scenario. All six of these households were able to increase consumption of the main staple – cassava – in order to help meet minimum consumption requirements.

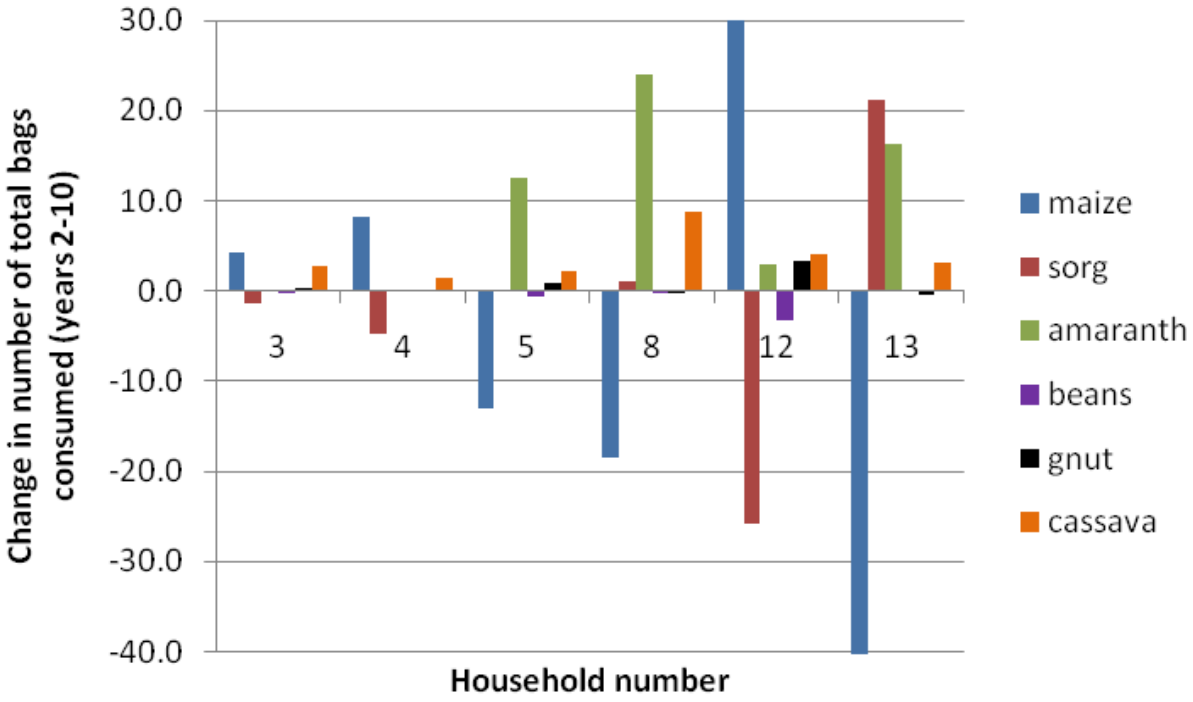

Figure 6-3. Changes in consumption of major foods for Amukura households under the AMAR scenario – households that failed to meet minimum consumption requirements under the BASIC scenario

However, with the adoption of grain amaranth by these households, not all foods were increased in the household diet (Figure 6-3) – the consumption of some foods actually decreased for every household. The largest impact upon household diets as a

result of the adoption of grain amaranth production for these six households was the reduction in consumption of another grain. For the three households (5, 8 and 13) that consumed the most grain amaranth, maize consumption was reduced by comparable numbers of bags, except for household 13 which also increased sorghum consumption at the expense of maize. For the other three households (3, 4 and 12), sorghum consumption was reduced in favor of increasing maize consumption.

The reason for these different responses was due to each household realigning their consumption strategies to provide the right balance of calories and protein to meet household needs. The households that did not adopt or adopted little grain amaranth for consumption were already doing better than the other struggling households in terms of protein consumption. Therefore, these households switched to maize consumption over sorghum consumption as maize offers more calories per kg than sorghum or grain amaranth. On the other hand, households that adopted grain amaranth for consumption in place of maize did so because they were struggling more to meet minimum protein requirements than minimum calorie requirements.

The impact of grain amaranth adoption was generally much smaller upon households that already met minimum consumption requirements under the BASIC scenario. This was because these households did not necessarily have to change their diets to meet any additional requirements – therefore all the changes in diet that these households made under the AMAR scenario enabled these households to increase the value of the objective funtion of the model – to generate more end cash in year 11. The greatest shift in diets for these households (1, 2, 6, 7, 10, 11, 15 and 16) occurred for those households that adopted grain amaranth for consumption (Figure 6-4). Selling

grain amaranth did not have as much of an impact upon diets as consuming grain amaranth.

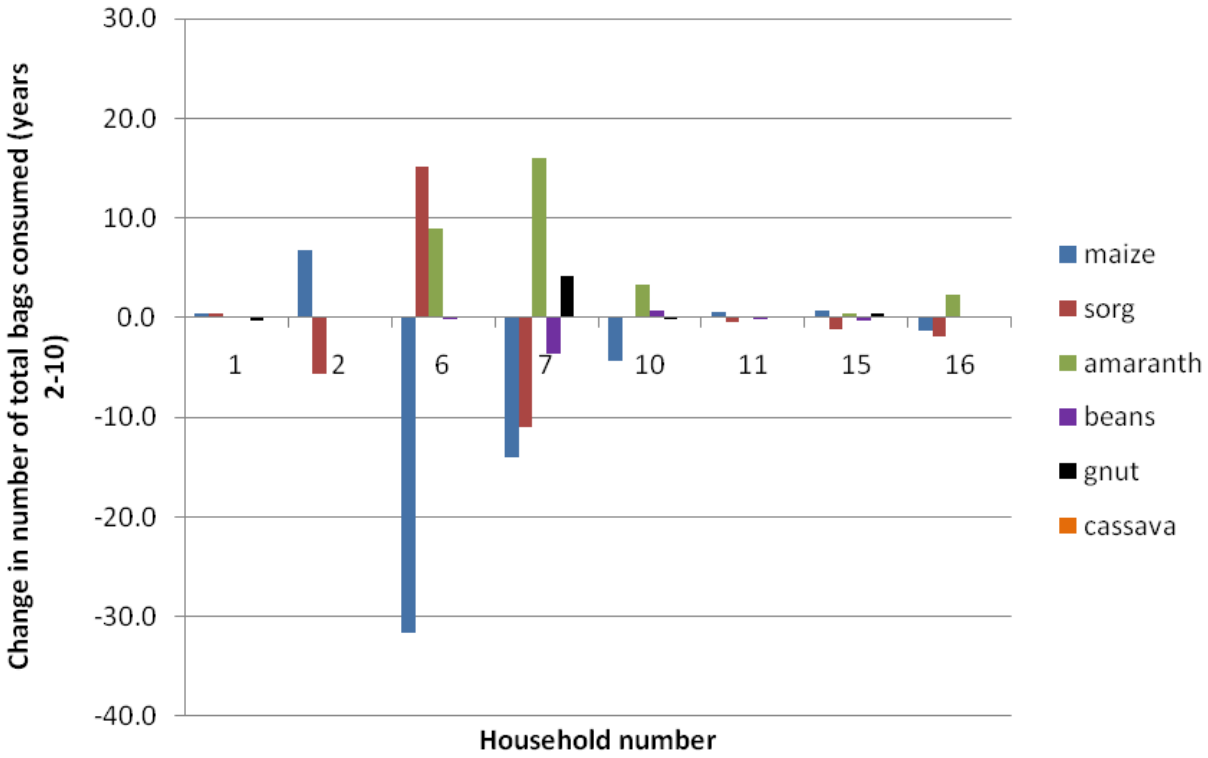

Figure 6-4. Changes in consumption of major foods for Amukura households under the AMAR scenario – households that already met minimum consumption requirements under the BASIC scenario

The changes in diet of these households followed a similar pattern to the previous six households discussed. The main impact upon diets brought about by grain amaranth adoption was a shift in the production of other grains. For households with fairly balanced compositions (7, 10 and 16) the uptake of grain amaranth for consumption meant a reduction in consumption of all other grains, due to reductions in production of grains for which both men (maize) and women (sorghum and finger millet) are responsible. Three households (1, 11 and 15) were not impacted significantly and maintained their same dietary behavior even with the generation of extra cash from

grain amaranth sales. Household 1 maintained this due to the lack of available male labor to invest in other dietary options. Households 11 and 15, meanwhile, were constrained by both available adult labor, the presence of young children in the household which needed to be cared for, and the lack of available land. All of these constraints restricted the ability of households 11 and 15 to alter their livelihood strategies under the AMAR scenario.

For the three households (2, 7 and 16) that reduced sorghum consumption (Figure 6-4), land was a significant constraining factor. As sorghum yields less protein per kg than grain amaranth and less calories per kg than maize, these households replaced sorghum production with these other grains to maximize their returns for consumption. Meanwhile, household 6 shifted towards sorghum production as a cheaper alternative to maize. This was because this household was able to send an extra youth to school in years 8-10. The shift to sorghum from maize occurs between years 5 and 10 so that the household can save more cash for school fees.

For all fourteen households that adopted grain amaranth, there was little change in legume consumption. Only three households (5, 7 and 12) exhibited a significant shift in dietary patterns concerning legumes. These households shifted from bean consumption to groundnut consumption (Figures 6-3 and 6-4). While households 5 and 12 both had large numbers of young children and high consumer-producer ratios, household 7 had a balanced household composition. Therefore, in terms of changes in legume consumption, household composition was not an important factor. However, these households were ones with the highest accumulations of additional end cash under the AMAR scenario (Figure 6-1). This was a more important factor in explaining changes in

legume consumption. Additional end cash generated by these households enabled them to diversify their diet and include groundnut consumption to supplement bean consumption. Groundnuts were the preferred dietary choice of households that had more cash as these legumes had more protein per kg than any other legume available in the livelihood system, and so helped households more easily meet their minimum protein requirements.

Impacts of grain amaranth adoption upon market sales by Amukura households

The adoption of grain amaranth production also impacted households' choices of the agricultural products to sell in the market. All fourteen households that adopted grain amaranth production for consumption and/or sale changed their selling activities as a consequence (Table 6-7).

The most significant impact was of grain amaranth adoption was the facilitation of sugar cane production and sales. All households except four (6, 11, 15 and 16) produced and sold more sugar cane as a result of adopting grain amaranth. Households 11, 15 and 16 produced and sold less sugar cane under the AMAR scenario due to two main reasons. First, these households had limited available male labor compared to other households, and investment in grain amaranth production resulted in a switch of some of their limited supply of male labor from sugar cane production. Secondly, these households were all land constrained and therefore reduced their acreage under sugar cane for grain amaranth production instead. Meanwhile, household 6 significantly reduced sugar cane sales because this household used the additional cash generated from grain amaranth sales in earlier years to meet school fee requirements. This meant that in later years this household did not have as much available cash to invest in sugar cane production.

Of the households that did increase sugar cane production, four households (2, 7, 12 and 13) made more than an additional 100,000Kshs from the sale of sugar cane under the AMAR scenario between years 2 and 10. These additional income gains from sugar cane production all came from later years in the model. The cash generated by additional market sales in early years as a result of the adoption of grain amaranth was then in later years invested in sugar cane production for households to generate more end cash in year 11 under the AMAR scenario than under the BASIC scenario. Sugar cane was the production activity in Amukura that generated the most cash income if adopted. However, sugar cane had high start-up costs and demanded continually high inputs of resources – land, labor and cash. The most important resource needed for sugar cane was cash – with cash, land could be purchased (rented or bought) and labor could be hired. Therefore, grain amaranth production for consumption and/or sale helped many households generate more cash in early years, and this cash later facilitated the expansion of sugar cane production.

Table 6-7. Change in market sales (Kshs) of agricultural products under AMAR scenario compared with BASIC scenario for households that adopted grain amaranth production (years 2-10).

Household (composition in years 1-4)	Change in market sales (Kshs)							
	Amaranth	Other grains	Legumes	Cassava	Sugar	Beer	Milk	Cow
1 (0-2-2-3-1)	15050	5542	2015	0	3598	-1234	0	0
2 (0-1-0-2-1)	81	-90108	12660	28060	119122	-426	14141	2075
3 (0-1-1-1-3)	16885	-12606	-23345	-1871	41219	-5249	18657	-3595
4 (0-1-0-0-2)	9299	-21502	1847	3956	857	-149	15371	-45
5 (1-1-0-0-2)	47603	1672	-42964	-12988	84636	0	3540	464
6 (1-1-3-3-1)	71024	57494	-59377	0	-92265	1631	-313	3608
7 (1-1-1-1-1)	22301	23200	-30122	0	184825	1052	18960	-183
8 (1-1-1-0-2)	129374	-32409	-40181	-56029	1565	788	3558	-2110
10 (2-3-3-2-0)	8282	20746	-36623	0	4303	7270	4821	-984
11 (1-1-0-0-0)	7700	-15833	4034	0	-2819	-341	0	0
12 (1-1-2-2-4)	110647	-67993	-97811	-28260	450313	2037	9093	3810
13 (2-1-1-0-1)	105336	31824	-31268	-60043	132829	-2330	3815	76
15 (1-1-0-0-1)	7466	-1027	7422	0	-15612	-514	0	0
16 (1-1-0-1-1)	3507	9020	4494	0	-30630	590	0	198

For eight households, legume sales declined, and in no household did legume sales increase. Households chose to reduce legume production for sale in favor of production of grain amaranth for sale. The main reason for this was that although grain amaranth's cash return (in terms of Kshs earned per acre) was slighter inferior to the potential cash returns from legumes, grain amaranth production utilized less labor than legumes. Therefore, in terms of switching away from legume production for sale, availability of labor became the most important factor.

Changes in sales of grains (excluding amaranth) varied among Amukura households. Maize sales increased significantly for households (6, 7, 10 and 13) that had reduced maize consumption as part of their household diet. These households were able to generate more cash through selling maize and eating other grains such as amaranth and/or sorghum instead. Meanwhile, grain sales declined for many other households (2, 3, 4, 8 and 12). These households were all either FHH or households with many children. They therefore had a high consumer-producer ratio and were not able to maintain sales of other grains while also producing grain amaranth for sale.

Another impact upon market sales was change in the sale of beer, although this was not a significant source of income. Beer sales by FHH declined as these households spent more time selling grain amaranth and did not have the additional labor to conduct both selling activities. Meanwhile, many MHH increased their beer sales. The additional cash generated from the sale of grain amaranth facilitated other activities of which the predominant male activity was sugar cane production while the main female activity that was increased was beer production.

Finally, the adoption of grain amaranth also facilitated the production and sale of milk. Households that had enough land and that were able to generate enough cash from grain amaranth sales often purchased more cows as a long-term investment strategy. The cows gave these households increased regular income through milk sales. Nine out of the fourteen households were able to increase their sales of milk in this way under the AMAR scenario.

Impact of grain amaranth adoption upon land and labor usage

The adoption of grain amaranth for consumption and/or sale brought about household changes in land and labor use. Under the AMAR scenario, all households used all available land every season in every year. This meant that six households (2, 3, 4, 5, 8 and 13) all increased their land usage to the maximum. This was because the production of grain amaranth provided a low-labor intensity opportunity to use the extra land that each household had available. Therefore, instead of renting-out fallow land, these households used that land for grain amaranth production because these households could generate more cash from producing grain amaranth than from renting out the land.

Two households (7 and 12) were able to rent-in more land under the AMAR scenario. These were the two households that generated the most cash from grain amaranth sales. Therefore, these households had the additional cash to afford to rent-in additional acreage. Household 6 was the only household that rented-in less land under the AMAR scenario. However, this household was able to generate enough cash from grain amaranth sales to purchase an additional acre, so renting-in land was not necessary.

These findings uncover a serious question – if land was completely utilized every season in every year by every household, where was any land available to rent? It is likely therefore, that in such a case, land prices would have increased at a competitive rate while demand outstrips supply. This would make renting-out land a more attractive livelihood strategy option for some households, and hence generate a supply of available land to be rented. This factor was not included in the model scenario, but is worth pointing out to illustrate that although modeling cannot answer all the questions, in-depth analysis of modeling results can uncover potential future scenarios that need to be carefully examined.

Table 6-8. Changes in household labor use (%) and hired labor (number of total days) for households that adopted grain amaranth production under AMAR scenario (years 2-10) compared with under BASIC scenario

Household (composition in years 1-4)	Change in household labor use (%)				Change in hired labor (number of total days)				
	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Total
1 (0-2-2-3-1)	0	0	0	0	0	-11	5	0	-6
2 (0-1-0-2-1)	0	0	0	0	12	13	2	-16	11
3 (0-1-1-1-3)	0	0	0	0	0	-9	0	3	-6
4 (0-1-0-0-2)	0	0	0	-1	4	16	16	8	44
5 (1-1-0-0-2)	8	0	0	6	0	1	0	0	1
6 (1-1-3-3-1)	0	1	0	-1	0	0	4	0	4
7 (1-1-1-1-1)	9	-3	1	9	0	0	0	0	0
8 (1-1-1-0-2)	6	4	0	7	0	0	78	0	78
10 (2-3-3-2-0)	0	2	1	0	0	0	0	0	0
11 (1-1-0-0-0)	0	0	0	0	0	0	-7	1	-6
12 (1-1-2-2-4)	0	4	0	16	0	0	0	0	0
13 (2-1-1-0-1)	12	7	4	2	0	0	88	55	143
15 (1-1-0-0-1)	0	4	0	0	0	0	0	0	0
16 (1-1-0-1-1)	0	1	0	0	0	0	-19	0	-19

In terms of impact upon labor usage, the adoption of grain amaranth brought about increases in household labor use for five households (5, 7, 8, 12 and 13). These households were all invested heavily in grain amaranth production for consumption

and/or sale. Household labor usage was increased for these households during periods which had unutilized labor under the BASIC scenario. Feb-Apr (the first season, in which most grain amaranth was sold) and Nov-Jan (the harvest of the last crop of amaranth, for the season in which most grain amaranth was consumed) were the two seasons in particular that witnessed increased labor activity (Table 6-8).

Grain amaranth production also brought about significant changes in hired labor. Four households (1, 3, 11 and 16) reduced their total amount of hired labor - household 11 no longer hired any labor, and household 16 reduced its total amount of hired labor by 92%. These households no longer had a significant need for hired labor as adopting grain amaranth production enabled them to meet household minimum requirements and generate more end cash. Meanwhile, households 2, 4, 8 and 13 increased their total amount of hired labor, with the biggest increases coming from households 8 and 13 – the two households requiring the biggest consumption reductions under the BASIC scenario. Hiring labor was therefore a lucrative strategy under the AMAR scenario for households increasing their consumption.

Mwatate

Adoption of grain amaranth for household consumption

Only two households (8 and 13) in Mwatate adopted grain amaranth production for consumption as a livelihood strategy under the AMAR scenario. However, these households did not adopt as much grain amaranth for consumption as many of the households in Amukura that adopted grain amaranth for consumption (Tables 6-1 and 6-9).

These households (8 and 13) were not able to meet both the minimum necessary protein and calorie requirements under the BASIC scenario. By adopting grain

amaranth, these households were able to increase their consumption and thus reduce malnutrition and improve food security (Table 6-10). By consuming grain amaranth, both households were able to increase their protein intake to the level necessary to meet protein requirements. Both households were also able to increase their calorie intake so that calorie reductions in consumption were less than 10% in years 2-4 and there were no calorie reductions in later years. Consuming grain amaranth increased these households' calorie intake. By adopting grain amaranth, these households were also able to save labor and generate increased cash at certain times that enabled them to increase production for consumption of other foods such as maize and cassava, as well as grain amaranth.

Table 6-9. Total consumption of grain amaranth (bags) for years 2-10 for Mwatate households

Household (composition in years 1-4)	Year 2	3	4	5	6	7	8	9	10	Total
8 (1-1-2-0-2)	0	0.80	0.37	0.37	0.21	0	1.39	0	0	3.15
13 (2-1-1-0-2)	0.03	2.46	0.32	0.74	0	0	0	0	0	3.56

Table 6-10. Mwatate households' change in calorie/protein consumption by time period under the AMAR scenario compared with the BASIC scenario

Household (composition in years 1-4)	Percentage reduction from minimum requirements under AMAR scenario						Percentage improvement under AMAR scenario compared with BASIC scenario					
	Calories			Protein			Calories			Protein		
	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10
8 (1-1-1-0-2)	9	0	0	0	0	0	25	9	0	28	0	0
13 (2-1-1-0-1)	6	0	0	0	0	0	30	4	0	29	0	0

Fourteen households did not adopt grain amaranth for consumption. This was significantly different from the number of households (seven) who did not adopt grain amaranth for consumption in Amukura. These fourteen households in Mwatate did not adopt grain amaranth for consumption as they already met consumption requirements

and therefore did not require additional protein or calories in their diets. Under the BASIC scenario these households were already able to produce enough household food by adopting other strategies.

The difference between the numbers of households adopting grain amaranth production for consumption in Mwatate compared with Amukura is due to two main factors: composition of diet and grain amaranth yields. Mwatate household diets were composed of a wider range of legumes which provided multiple diverse sources of protein to these households, while the bulk of calories in their diets were provided by maize. In particular, pigeon pea production for consumption was very common among Mwatate households – this was not a livelihood strategy option for Amukura households as the Amukura climate was generally too wet for pigeon pea production. Pigeon pea production required less labor than other legumes as the pigeon pea plants could be harvested for two years before replanting was necessary due to declining yield. Thus, producing legumes and providing protein in their diets typically required fewer resources for Mwatate households than for Amukura households. In addition to this difference in diet, grain amaranth yields were lower in Mwatate than in Amukura. Overall, therefore, there was less incentive for Mwatate households to adopt grain amaranth production for consumption than for Amukura households, resulting in the difference between the two communities in number of households consuming grain amaranth.

Annual and seasonal variation in grain amaranth consumption

Amaranth consumption in households 8 and 13 varied in a similar pattern to Amukura households that adopted grain amaranth for consumption. As these two households obtained greater food and cash security over time, so grain amaranth production for consumption declined (Table 6-9). As these households generated

increased income over time, they used the additional cash to invest in other ways to get protein into their diets, rather than continuing to consume grain amaranth. These households especially increased their purchases of legumes in later years to supply protein for household consumption, as this required the investment of fewer resources than grain amaranth production for consumption.

Table 6-11. Seasonal variation in grain amaranth consumption (total bags consumed years 2-10)

Household (composition in years 1-4)	Feb-Apr	Aug-Oct
8 (1-1-2-0-2)	2.82	0.33
13 (2-1-1-0-2)	2.18	1.37

Consumption of grain amaranth by households 8 and 13 also varied seasonally. These households produced more grain amaranth for consumption in the February-April season than in the August-October season (Table 6-11). One reason for this difference was that labor was more available in this first season, as this was not as busy a time of year compared with the later season. Thus, in the first season more labor could be used for producing grain amaranth for consumption. Another important reason for this seasonal variation was that these households were more food insecure in the first season under the BASIC scenario. Therefore, more grain amaranth was consumed in this first season in order to help make up for the larger shortfall facing these households at that time of year.

Adoption of grain amaranth for sale

Grain amaranth was also adopted by Mwatate households for sale. Households that sold grain amaranth in Mwatate fell into two categories, just as in Amukura – those that sold surplus grain amaranth that they did not consume, and those that sold grain amaranth but did not consume any. Half of the sixteen households in Mwatate sold

grain amaranth under the AMAR scenario (Table 6-12). These included households 8 and 13 which grew amaranth for consumption, as well as six other households that only grew amaranth for sale.

Table 6-12. Total sales (bags) of grain amaranth by Mwatate households (years 2-10)

Household (composition in years 1-4)	Total bags sold
1 (0-2-2-3-1)	0
2 (0-1-1-1-1)	0
3 (0-1-1-2-2)	0
4 (0-1-1-0-1)	0
5 (1-1-0-0-2)	8.43
6 (1-1-3-3-1)	3.05
7 (1-1-1-1-1)	0
8 (1-1-2-0-2)	82.99
9 (1-2-1-1-2)	0
10 (2-2-2-2-1)	0
11 (1-1-0-0-0)	5.94
12 (1-1-2-2-3)	15.15
13 (2-1-1-0-2)	82.99
14 (1-3-1-2-4)	0
15 (1-1-1-0-1)	5.33
16 (1-1-0-1-1)	5.30

Households 8 and 13 had the highest total sales of grain amaranth. These were the households that also grew amaranth for consumption, so were selling surplus after taking what they needed for consumption. Households 8 and 13 were the only households that faced consumption reductions under the BASIC scenario. Both consuming and selling grain amaranth were strategies that were most adopted by the most food insecure households in Mwatate. One reason for this trend was that those households that invest in grain amaranth production for consumption have already invested in grain amaranth production also have the resources to produce grain amaranth for sale. Furthermore, there is a reinforcing circle in which the benefits obtained from the consumption of grain amaranth by household members encourages

these households to produce more amaranth, thus encouraging more consumption, and consequently more sales, as a household's surplus of grain amaranth increases.

The two households with the next highest total sales of grain amaranth were households 5 and 12, yet their sales were less than 20% of either household 8 or 13 (Table 6-12). All households that sold grain amaranth were able to do so because they had access to additional land that could be brought under cultivation. Households 6 and 15 were able to use cash to rent additional land area, while the other six households that cultivated grain amaranth for sale were able to do so through an expansion onto pre-owned household land. Due to the high tolerance of drought of grain amaranth, this is an extremely likely outcome – that grain amaranth will be cultivated on poorer soils or sub-prime land. It is not likely that grain amaranth will ever be cultivated on the most fertile soils, as grain amaranth is not expected to replace the staple crops, only supplement them. Therefore, the expansion onto poorer lands for the purposes of cultivating grain amaranth is a very probable situation.

The other eight households in Mwatate did not adopt grain amaranth for sale or consumption due both to resource constraints and greater potential benefits from other livelihood strategies. With regards to resource constraints, households 1, 2, 3 and 4 (FHH) lacked the gender balance in labor availability to cultivate grain amaranth. These households were also among those with the smallest amounts of available end year cash, and so lacked the available cash for investing in grain amaranth production. On the other hand, households 7, 9, 10 and 14 lacked available land to produce grain amaranth, as they were already using 100% of their available land in both seasons under the BASIC scenario. The high price of rental land further prohibited these

households from obtaining land on which grain amaranth could be produced. In addition, these four households had plentiful available female labor to focus on maintaining the food production strategies and sufficient male labor to continue to focus on the cash generating production strategies adopted under the BASIC scenario. Therefore, this combination of lack of available additional land and no appreciable labor deficits provided no incentives for these households to adopt grain amaranth production. In addition, with regards to greater potential benefits from other livelihood strategies, these households were able to generate more end year cash from the sales of other foods than they would have been able to generate from grain amaranth sales. Instead of investing in grain amaranth, these households invested in maize, the staple crop of Mwatate, and in various legumes, through which they stood to generate more end cash than through grain amaranth. These households also demonstrated resistance to change from familiar livelihood strategies such as cultivating maize for sale to unfamiliar (and thus perceived-to-be potentially risky) livelihood strategies such as cultivating grain amaranth.

Eight households (1, 3, 6, 8, 9, 10, 12, and 13) in Mwatate were unable to send all their youths to school under the BASIC scenario. Four of these households (1, 3, 9 and 10) did not adopt grain amaranth production for sale as a livelihood strategy under the AMAR scenario, so these households' strategy decisions were unchanged from the BASIC scenario. Although the other four households (6, 8, 12 and 13) adopted the sale of grain amaranth as a livelihood strategy under the AMAR scenario, none of these households were able to generate sufficient cash to increase the school enrollment of youths in their respective households. Households 8 and 13 generated the largest

increase in accumulative end cash between the BASIC and AMAR scenarios (Figure 6-5). This was directly due to the large production of grain amaranth for sale (Table 6-12). However, this cash was used to enable these households to increase their consumption, especially in years 1-4, and there was consequently not enough additional cash that could be used to send more youths to school from these households.

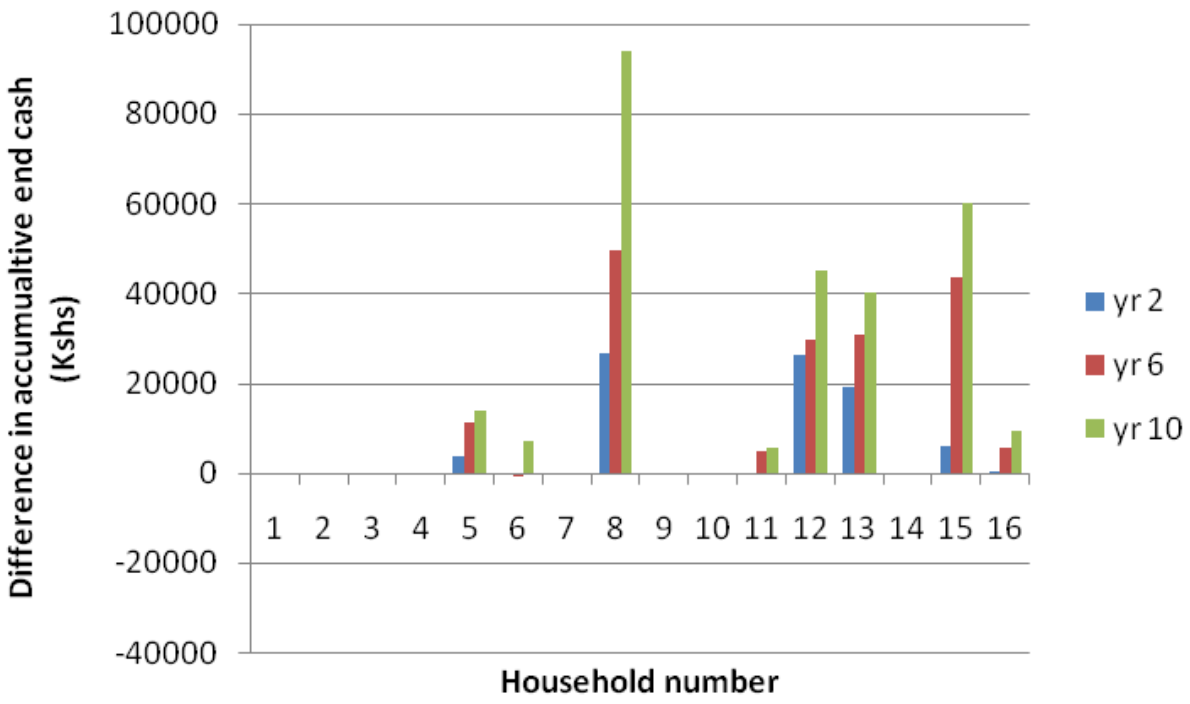

Figure 6-5. Change in Mwatate households' accumulative end cash (years 2, 6 and 10) from the BASIC to the AMAR scenario

The other two households that were able to generate a significant increase in accumulative end cash between the BASIC and AMAR scenarios were households 12 and 15 (Figure 6-5). Household 12 had a large number of youths, which provided this household with a large labor supply, especially in the years when they were not attending school. The increase in accumulative end cash in household 12 is directly linked to the increase in use of available labor. However, this cash increase still was not

sufficient to send more youths to school. Household 15, on the other hand, was already able to send all its youths to school. This household was able to generate a significant increase in accumulative end cash due to its balanced labor supply that enabled a shift in production to maximize accumulative cash.

Annual and seasonal variation in grain amaranth sales

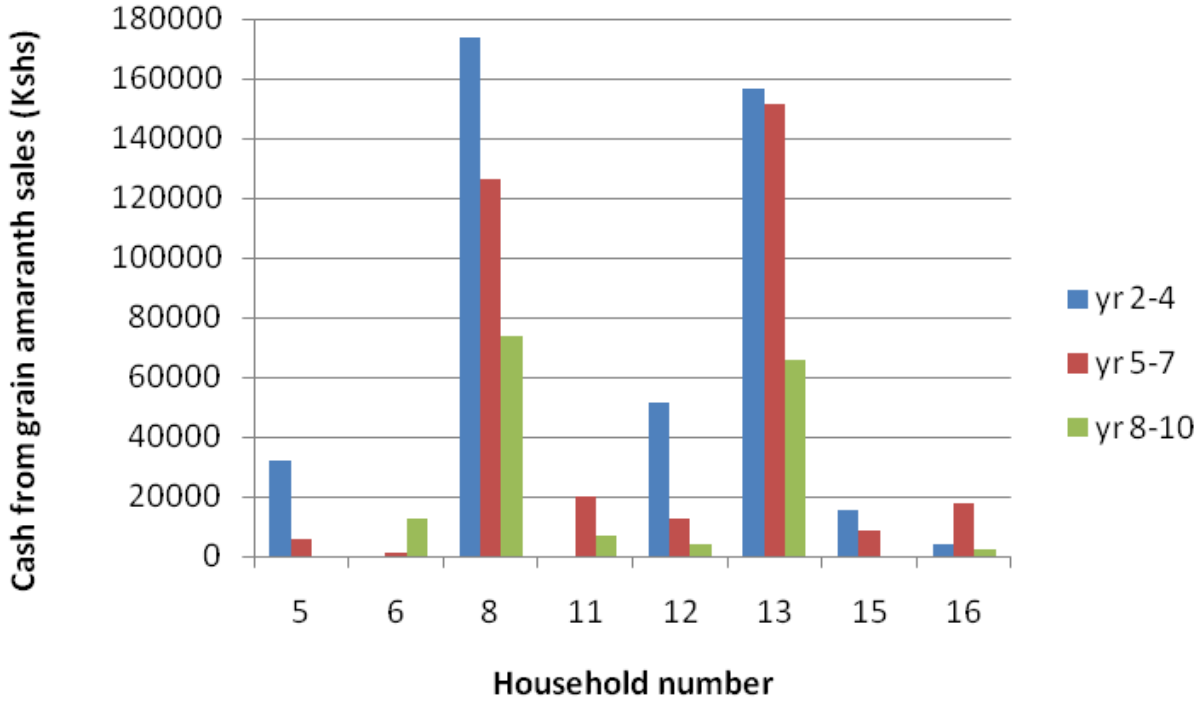

Figure 6-6. Variations over time in the sale of grain amaranth by Mwatate households

Overall, all households that adopted the production of grain amaranth for sale increased their accumulative end cash. However, the increases in accumulative end cash varied substantially based on the constraints facing and resources available to each household. This variation in constraints and available resources underpins all the differences in decisions regarding the adoption of grain amaranth for consumption and/or sale.

Sales of grain amaranth varied seasonally and annually both among and within households in Mwatate. There were two general patterns of variation on an annual timescale. First, household sales of grain amaranth in general declined over time, with five of the eight households that sold grain amaranth selling the most amaranth in years 2-4 (Figure 6-6). This resonates with findings from Amukura – households sell the most grain amaranth when they are struggling financially. As these households manage their resources and make livelihood decisions accordingly over time, most are able to accumulate increasing amounts of end year cash. With increasingly available amounts of cash, these households correspondingly have reduced interest in selling grain amaranth.

Secondly – and different from Amukura – the sales of grain amaranth by most households in Mwatate fluctuated every year on an alternating pattern, with one year of high sales followed by another year of low sales (Figure 6-7). This alternating pattern corresponded with annual fluctuations in pigeon pea sales by these households – when pigeon pea sales were high, grain amaranth sales were low, and vice-versa. This was due to differences in yields of pigeon peas between odd and even years in the model, as yields of pigeon peas were lower in the second year (odd years) after planting than in the first year (even years). This displayed a common tactic that was deployed by households in Mwatate to avoid flooding the market with the same crop product each year so as to regulate market supply and maintain good prices for both grain amaranth and pigeon peas.

Not all households followed this strict fluctuating pattern, however. Sales of grain amaranth by households 6, 8 and 13 did not follow any consistent pattern, and were

sometimes greater in years in which other household sales of grain amaranth were low. Households 8 and 13 did not invest heavily in selling pigeon peas in early years due to both lack of available cash and the need to keep the majority of food produced for household consumption. As a result, the sales of grain amaranth by these two households did not fluctuate in the alternating pattern until later years when other crops were adopted to a greater extent as a livelihood strategy focused on sales. On the other hand, household 6 only sold grain amaranth in years 7 and 8 when the household was stressed due to a high consumer-producer ratio.

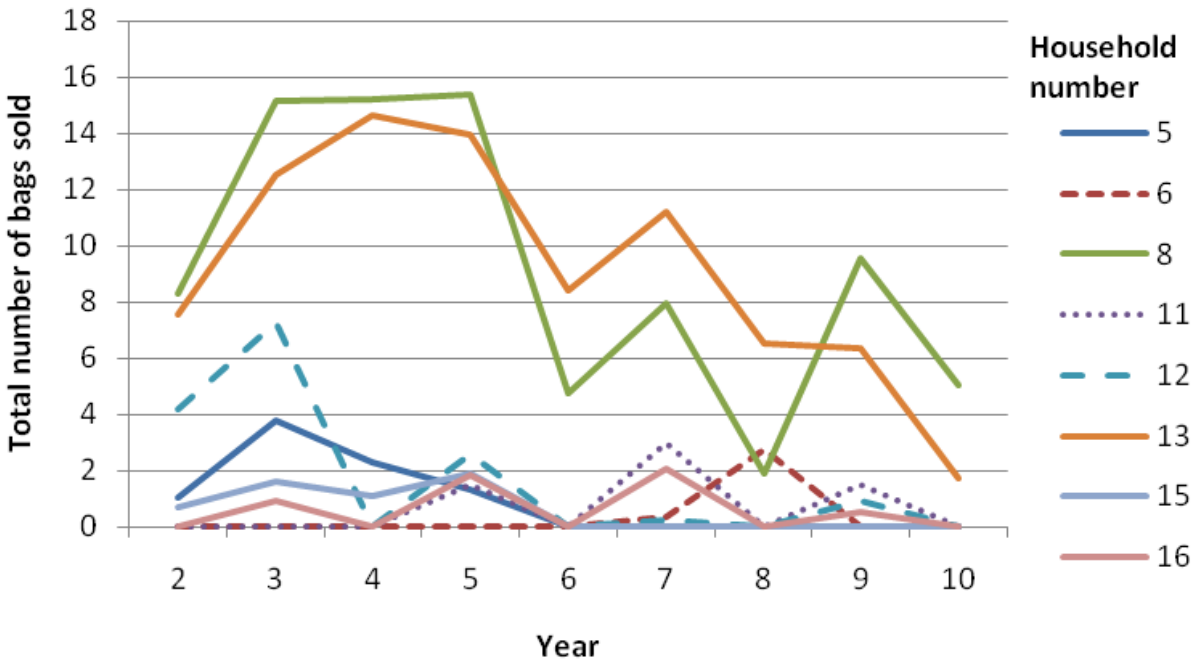

Figure 6-7. Annual sales of grain amaranth by Mwatate households

Sales of grain amaranth were higher for every household in the August-October (second) season than in the February-April (first) season (Table 6-13). Due to the high demands of other essential livelihood activities on available labor in the later season, producing grain amaranth for sale was considered a more useful livelihood strategy at this time of year due to its short growing season which allowed a quick return on an

investment. Sales of grain amaranth were also higher later in the year as households required more cash at the end of the year than earlier in the year in order to meet end cash requirements such as school fees.

Table 6-13. Seasonal sales of grain amaranth by Mwatate households (total bags sold years 2-10)

Household (composition in years 1-4)	Feb-Apr	Aug-Oct
1 (0-2-2-3-1)	0	0
2 (0-1-1-1-1)	0	0
3 (0-1-1-2-2)	0	0
4 (0-1-1-0-1)	0	0
5 (1-1-0-0-2)	1.98	6.45
6 (1-1-3-3-1)	0	3.05
7 (1-1-1-1-1)	0	0
8 (1-1-2-0-2)	34.73	48.26
9 (1-2-1-1-2)	0	0
10 (2-2-2-2-1)	0	0
11 (1-1-0-0-0)	0	5.94
12 (1-1-2-2-3)	2.17	12.98
13 (2-1-1-0-2)	33.43	49.56
14 (1-3-1-2-4)	0	0
15 (1-1-1-0-1)	0.85	2.29
16 (1-1-0-1-1)	0	5.30

Impacts of grain amaranth adoption upon household diets

The adoption of grain amaranth as a livelihood strategy option for consumption and/or sale had significant impacts upon Mwatate household diets. The greatest impact on overall diets was felt by households 8 and 13, which had failed to meet minimum consumption requirements under the BASIC scenario, primarily due to their imbalance of gender division of household labor – an abundance of male labor, yet a dearth of available female labor, which was more important for food production. These were the only two households to produce grain amaranth for both consumption and sale. These households were able to increase overall consumption of almost all foods under the

AMAR scenario (Figure 6-8). This resulted in these households almost being able to meet minimum consumption requirements under the AMAR scenario – a significant improvement in household food security compared with the BASIC scenario.

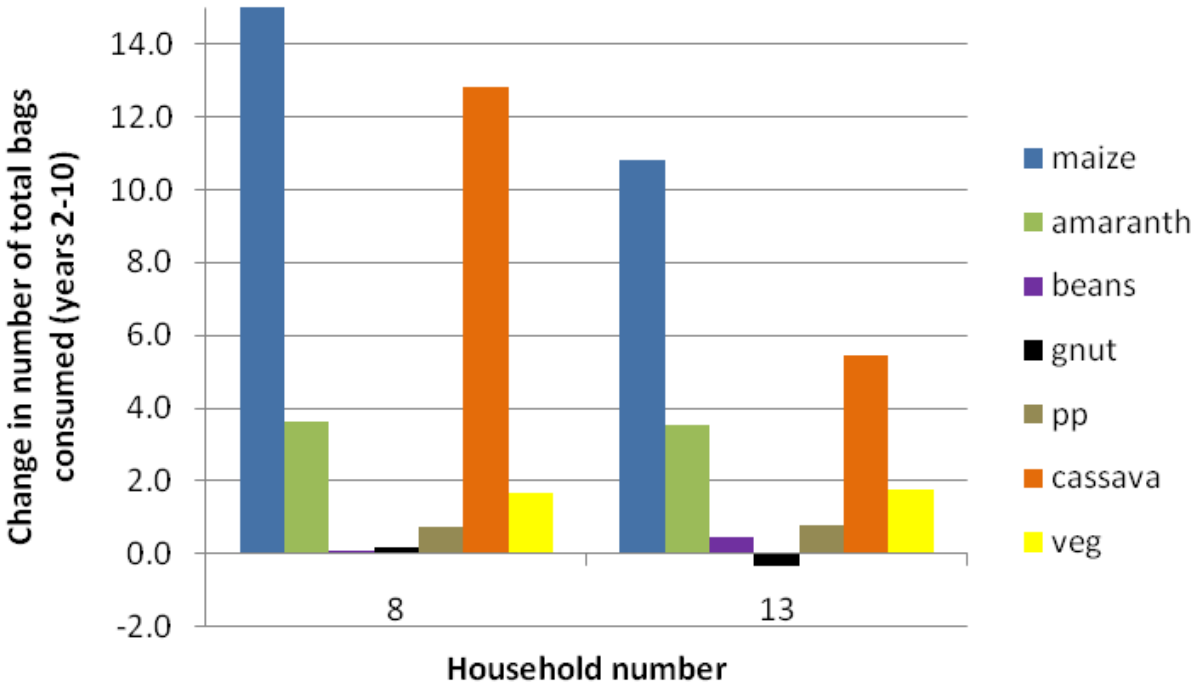

Figure 6-8. Changes in consumption of major foods for Mwatate households under the AMAR scenario – households that failed to meet minimum consumption requirements under the BASIC scenario

The biggest increase in numbers of bags consumed by these households was in the consumption of staples such as maize and cassava. However, cassava increases for these households were the most significant, as these represented a 7-fold and 2.5-fold increase in cassava consumption for household 8 and 13 respectively under the AMAR scenario compared with the BASIC scenario. In comparison, increase in consumption of maize by households 8 and 13 under the AMAR scenario were only 11% and 7% compared with the BASIC scenario. Cassava increases were primarily due to its low market value (in comparison with other staples) and its low labor demands for

production. Therefore, for these food insecure households, cassava was the easiest food to access either through production or the market in order to increase household consumption.

Legume consumption also increased under the AMAR scenario in households 8 and 13. Pigeon pea consumption increased the most of all legumes, as this legume only had to be replanted every other year to produce a regular harvest. Bean consumption also increased slightly for both households, while groundnut consumption increased for household 8 but decreased for household 13 (Figure 6-8). These changes in legume consumption reflect the adoption of grain amaranth into the diet of these two households. As grain amaranth could provide a high protein intake for these households at a lower resource cost than all legumes, increases in protein necessary to meet minimum household requirements could be provided through consuming grain amaranth rather than significantly increasing the consumption of legumes.

The impact of grain amaranth adoption upon household diets was not as significant in the six households that only produced grain amaranth for sale. Similar to Amukura, this was because these households did not require any changes in diet to meet minimum consumption requirements – all the changes in diet these households made were to increase accumulative end cash by selling those crops with greater market value.

Adopting grain amaranth for sale led to varied responses in terms of diet changes by these six households (Figure 6-9). The main change in legume consumption was a trend in diets away from groundnuts and/or pigeon peas towards beans. This was because beans required fewer inputs in terms of initial cash for seed purchasing, were

typically intercropped with maize, and were ready for harvest in 75 days in comparison with over 100 days for both pigeon peas and groundnuts. Therefore, grain amaranth could be adopted for sale by these six households (5, 6, 11, 12, 15 and 16) because they experienced an increase in available land due to a switch to beans from other legumes.

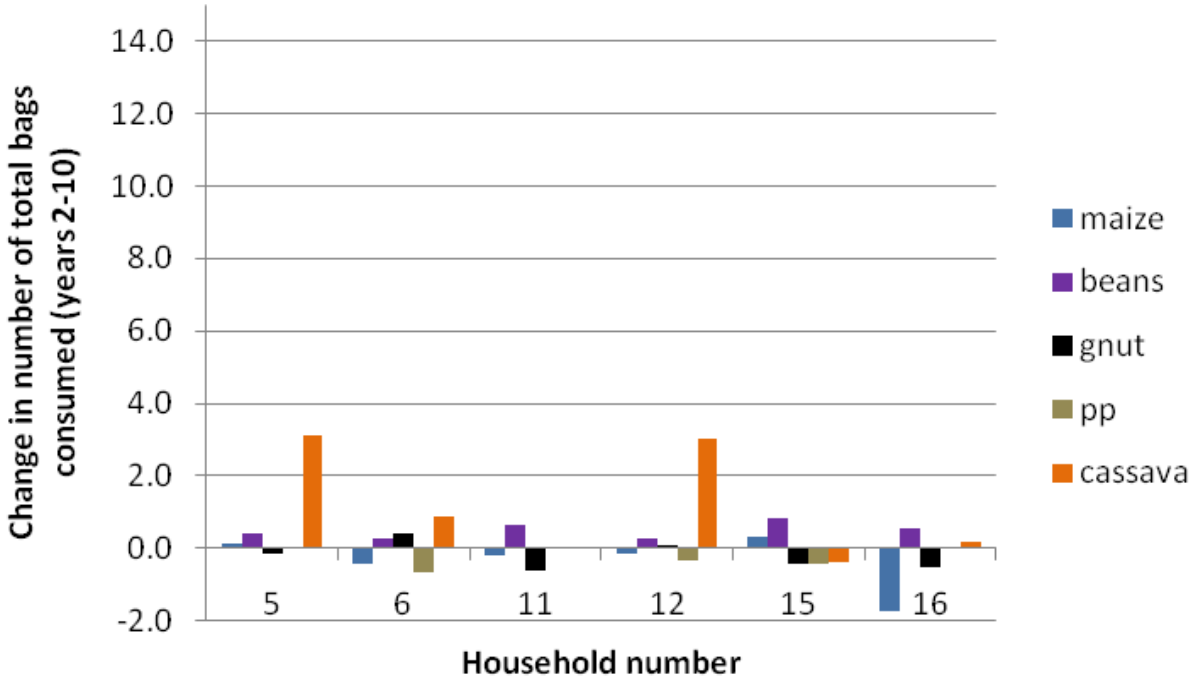

Figure 6-9. Changes in consumption of major foods for Mwatate households under the AMAR scenario – households that met minimum consumption requirements under the BASIC scenario

Two households (5 and 12) significantly increased cassava consumption under the AMAR scenario (Figure 6-9). This was due to household composition – these households had plenty of available female labor, but little available male labor. As cassava production was a female labor-intensive crop, a switch to more cassava in their diets in place of maize and/or legumes resulted in making male labor available for grain amaranth production. Meanwhile, two other households (6 and 16) significantly reduced

their consumption of maize under the AMAR scenario (Figure 6-9). This was an alternative strategy to that chosen by households 5 and 12, but with the same result – male labor was made available for grain amaranth production.

Impacts of grain amaranth adoption upon market sales by Mwatate households

The adoption of grain amaranth production not only changed household diets but also changed household sales of agricultural products. The sale of grain amaranth by households in Mwatate resulted in shifts in sales of other agricultural products. Although most of these shifts involved a reduction in sales, in some instances the sale of grain amaranth also resulted in an increase in sales of certain commodities.

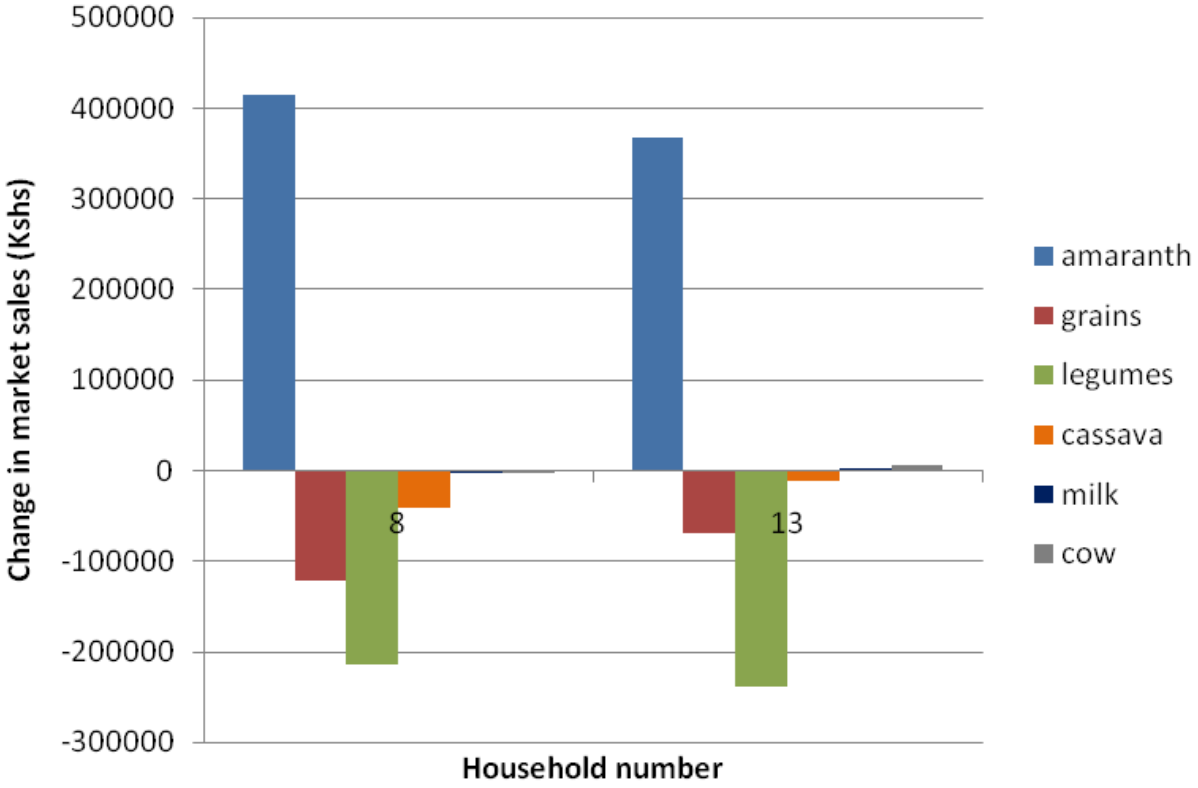

Figure 6-10. Change in market sales (Kshs) of agricultural products under AMAR scenario compared with BASIC scenario for households 8 and 13 that adopted grain amaranth production for both consumption and sale (years 2-10).

For the two households (8 and 13) that adopted grain amaranth as both a food and a cash crop, the changes in household market sales were much larger than for the other six households in Mwatate that only adopted grain amaranth as a cash crop. For households 8 and 13, the sale of grain amaranth did not result in a significant increase in the sale of any other agricultural product. Instead of grain amaranth sales by these households being in addition to the sales of other products, grain amaranth sales replaced the sales of many products. The largest shifts in sales by these households were reductions in the sale of legumes, followed by reductions in the sale of grains (Figure 6-10). Household labor that had been used under the BASIC scenario to produce legumes and grains for sale was now shifted in part under the AMAR scenario to produce grain amaranth, which required fewer resources and generated a return on investment more quickly due to its short growing season.

For the six households in Mwatate that adopted grain amaranth as only a cash crop, shifts in the adoption of livelihood production strategies for market sale were more diverse than for households 8 and 13 due to the differences in household composition and resource allocation among the six households (Figure 6-11). The shift in market strategies adopted by households 5 and 11 is similar to the shift adopted by households 8 and 13. Households 5 and 11 adopted the sale of grain amaranth at the expense of other selling activities. These two households were constrained by available land and labor – therefore adopting grain amaranth was at the expense of cultivating something else. These households both lacked youth labor, especially in years 1-4, while female labor was constrained by having to care for many young children. Therefore, under the AMAR model, the sale of grain amaranth by these households replaced in part the sales

of all other agricultural products. At first glance, the market strategy shift of household 6 appears similar to that of households 5 and 11. However, by selling grain amaranth, household 6 was able to generate enough cash to buy an extra bovine to keep for milking. Household 6 also had plenty of available youth labor for this additional milking requirement, as well as land that was not in use under the BASIC model that could be used for keeping the extra cow. Hence, the sale of grain amaranth resulted in an increase in milk sales for this household.

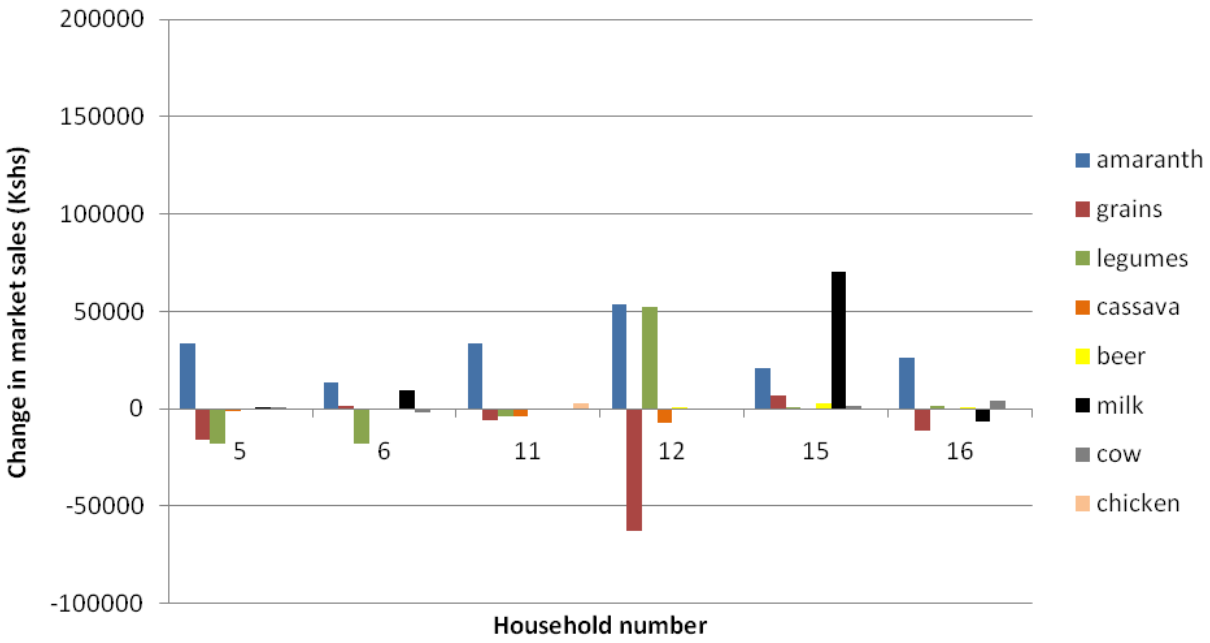

Figure 6-11. Change in market sales (Kshs) of agricultural products under AMAR scenario compared with BASIC scenario for the six households that adopted grain amaranth production for sale only (years 2-10).

The shifts in market strategy by the other three households (12, 15 and 16) were diverse and distinct from shifts experienced by households 5, 6 and 11. The sale of grain amaranth by household 12 resulted in a large increase in the sale of legumes and a correspondingly large decrease in the sale of grains, particularly maize. Household 12 was one of the largest households in terms of total number of members and also had

one of the largest available land areas. This enabled household 12 to maximize end cash under the AMAR scenario through the adoption of a rotation system of sales – selling predominantly legumes in one year and grain amaranth the next year. Household 12 was able to focus its production on either legumes or grain amaranth each year so as to maximize production and end cash. Maize sales declined as legume and amaranth sales generated a higher return for the investment.

Household 15 was unique among all households in Mwatate, as grain amaranth sales did not replace the sale of any other agricultural product, but instead spurred on further market sales. The largest shift that occurred in household 15 as a result of selling grain amaranth was an increase in milk sales. This household was constrained by available female labor in years 1-4 when there was no female youths and in years 8-11 when available female labor was taken up with the addition of another child to the household. Therefore, the cash generated from amaranth sales by this household enabled investment in cattle, which required only low labor inputs. These cattle were not sold but kept to produce milk as a regular cash income for this household. In comparison, household 16 also invested in more cattle under the AMAR scenario, yet this household did not keep the cattle for milk but sold the cows for cash. This household had a balanced household composition, yet did not have enough available land year-round to keep the cattle, and so selling the cows themselves rather than using the cows for milk production was the preferred livelihood strategy option.

Overall, the impacts of selling grain amaranth upon household market livelihood strategies in Mwatate were more diverse than the impacts upon household strategies in Amukura. Whereas in Amukura trends for each agricultural product could generally be

discerned across households, the impacts upon Mwatate households were more varied and highly dependent upon household composition and resource allocation.

Impact of grain amaranth adoption upon land and labor usage

The adoption of grain amaranth for consumption and/or sale affected Mwatate households' land and labor use. Under the AMAR scenario, six households increased their land usage – these were all households that adopted grain amaranth production. Three of these six households (5, 11 and 13) increased their land usage to the maximum available, while the other three households increased land usage but could not quite use all their available land because they had used all available labor. These households were able to increase their land usage as the cash that had been generated from grain amaranth sales provided these households with sufficient additional income to invest in additional seed, fertilizer and/or hired labor for production purposes. Of all six households, households 8 and 13 had the biggest increase in land usage in order to produce as additional food as possible in attempts to meet minimum consumption requirements. Only two households (6 and 15) that adopted grain amaranth production did not increase their usage of land that they owned because these households were already using all available owned land. Household 15, however, did rent additional land to be used for grain amaranth production.

Five of the eight households that adopted grain amaranth increased their household labor use (Table 6-14). This was directly related to the increase in land usage by these households. Under the BASIC scenario, these households had surplus labor, yet had utilized all available land and had insufficient cash to either rent or purchase additional land. Therefore, with the increase in cash generated from grain amaranth sales, these households were able to utilize their surplus labor for production

on additional available household land. The biggest increase in labor use was in households 8 and 13 in order to increase household consumption. These households increased labor use in every season. Household 15 also increased labor use significantly in order to utilize its newly rented land under the AMAR scenario.

Table 6-14. Increase in household labor use (%) and hired labor (number of total days) under AMAR scenario (years 2-10) for households that adopted grain amaranth production

Household (composition in years 1-4) number	Increase in household labor use (%)				Increase in hired labor (number of total days)				
	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Total
5 (1-1-0-0-2)	4	3	1	0	0	0	0	-13	-13
6 (1-1-3-3-1)	0	0	0	0	0	0	0	0	0
8 (1-1-2-0-2)	7	20	5	6	-31	0	0	-12	-43
11 (1-1-0-0-0)	0	0	0	0	5	0	0	92	97
12 (1-1-2-2-3)	2	4	0	0	0	0	0	0	0
13 (2-1-1-0-2)	18	14	25	5	0	0	0	-5	-5
15 (1-1-1-0-1)	8	9	3	4	0	0	0	0	0
16 (1-1-0-1-1)	0	-4	0	0	0	0	0	32	32

The adoption of grain amaranth production also greatly affected household abilities to hire labor (Table 6-14). There were no changes in hired labor in the May-July and August-October seasons, some changes in the February-April season, and many changes in the November-January season. This last season was the time of year in which households dealt with the harvest and sale of products from the second wet season of the year. Households 11 and 16 significantly increased their total amount of hired labor by 91% and 37% respectively, predominantly in the November-January season. These households were lacking in labor supply – particularly in youth labor – and so the sale of grain amaranth generated enough cash for these households to be able to hire additional labor for agricultural production activities. Meanwhile, households 5, 8 and 13 all reduced the amount of labor they hired in this last season, and, for

household 8, in the February-April season as well. By adopting grain amaranth production for sale and/or consumption, these households were able to generate more cash (and more food in the case of households 8 and 13) without having to hire as much labor as under the BASIC scenario. Under the AMAR scenario, therefore, hiring labor was a more desirable option for some households and a less desirable option for others dependent upon how much additional end cash it could generate for a specific household.

Conclusions

This analysis of household decisions concerning grain amaranth adoption in Amukura and Mwatate revealed distinct patterns of adoption. There were both households that were likely to adopt grain amaranth and those that were unlikely to adopt grain amaranth due to various constraints. Many households that adopted grain amaranth for sale did not incorporate grain amaranth into their household diet. These patterns of differential adoption were dependent upon household resource availability of labor, land and cash that fluctuated both seasonally and annually. In order to draw conclusions from this analysis, it is important to refer back to the purpose of this chapter, namely to answer Research Question 3:

RQ3: For which kinds of household is grain amaranth production a feasible livelihood strategy option in these communities (Amukura and Mwatate)?

The findings from this chapter indicated that households that adopted grain amaranth production in these communities generally fell into one or more of three categories: households whose consumption was protein-deficient; households that were struggling to make ends meet; households that had plenty of male labor but are lacking in female labor.

Households Lacking Sufficient Protein

Grain amaranth is high in protein compared to other grains, and requires less time for food preparation compared with legumes. Therefore, grain amaranth is a viable additional or alternative source of protein, especially for households that struggle to meet minimum protein requirements. Out of the sixteen households modeled in Amukura, nine households adopted grain amaranth for consumption and fourteen households adopted grain amaranth for sale. In comparison, only two households adopted grain amaranth for consumption and eight for sale in Mwatate. This difference between the two communities is directly related to the current livelihood system into which grain amaranth is being introduced. The Amukura livelihood system provided a wider range of livelihood strategy options for households, yet these options were typically lacking in the provision of protein. Therefore, many households adopted grain amaranth as a source of protein in their diets. In Mwatate, there was a wider range of legumes available for inclusion in household diets, and therefore more potential protein sources – therefore, grain amaranth was not adopted as much in this community.

Households Struggling to Make Ends Meet

The adoption of grain amaranth production enabled struggling households to reduce their food insecurity. In both Amukura and Mwatate, the most food-insecure households under the BASIC scenario were able to increase their calorie and protein intakes under the AMAR scenario. These households achieved these increases either through directly incorporating grain amaranth into their diets or through selling grain amaranth to generate cash to purchase other foods. In addition, households that were struggling the most financially were the ones that generated the highest sales of grain amaranth. Grain amaranth production for sale was a lucrative activity for struggling

households as it promised a rapid and decent-sized financial return on a relatively small investment of labor, land and cash compared with other cropping enterprises. However, the adoption of grain amaranth production in itself was not enough to increase the financial security of struggling households. Under the AMAR scenario, only one household in Amukura and none in Mwatate were able to send more youths to school than under the BASIC scenario. Greater shifts in financial security of households in both communities came as a result of changes not in grain amaranth adoption, but in household composition and consumer-producer ratios. When household compositions shifted to higher C/P ratios, households became less financially secure, as fewer producers and more consumers resulted in outgoing cash increasing while incoming cash decreased. In addition, households that lacked available adult male labor struggled to generate sufficient cash to send youths to school year after year.

In general, however, households in both communities did not continue to produce grain amaranth once they were no longer struggling to meet minimum consumption and cash requirements. Instead, once these households had enough cash, grain amaranth production was abandoned in favor of other strategies that required larger resource investments but promised larger cash returns. Therefore, grain amaranth production was more likely to be limited to households with fewer available resources in a community.

Households with a Certain Gender Division of Labor

An assessment of the various necessary tasks for grain amaranth production reveals that a balance of male and female labor is required. Despite this, in comparison to legume production, the usual primary dietary source of protein in Amukura and Mwatate, grain amaranth production requires significantly more male labor than female

labor. Grain amaranth production for consumption was therefore not adopted by FHH, as these households were lacking in adult male labor. Instead, these FHH continued to rely on obtaining dietary protein from legumes, which required more female labor than male labor to produce. Grain amaranth was only adopted by FHH in situations where these households stood to generate significant cash increases from grain amaranth sales. This additional cash could then be used by these FHH to hire additional male labor to increase household agricultural production.

Grain amaranth production for consumption had better prospects among MHH specifically among households in which the amount of available male labor was significantly greater than the amount of available female labor. An abundance of male labor compared to available female labor allowed these households to adopt grain amaranth as an additional or alternative source of dietary protein, as previously (under the BASIC scenario) these households had expended the majority of their female labor on legume production in order to meet household minimum protein requirements. In addition, as grain amaranth was considered to be a “male” crop when it came to market, more MHH adopted grain amaranth production for sale than FHH which had no adult male to market the crop.

Extending the Analysis

Grain amaranth was therefore a feasible livelihood strategy option for some, but not all households in both Amukura and Mwatate. The decision concerning adoption of grain amaranth by a household was contingent upon available resources of land, cash and labor, especially household composition, and the fluctuating livelihood decisions made over time by a household. The patterns of household decision-making concerning grain amaranth adoption that have been identified here can help future amaranth

promotion efforts identify and target types of household that are most likely to adopt grain amaranth so that early efforts to extend grain amaranth production to a new community can be successful. In addition, grain amaranth extension efforts can be improved by identifying the types of households that are unlikely to adopt grain amaranth at first, and so prioritize the extension effort for maximum impact. The issue of how to put into practice the findings from the analysis in this chapter is explored in detail in Chapter 8. Before that is addressed, however, this analysis is first extended further in order to account for common scenarios in Kenyan households - assessing the impact of HIV infection of an adult household member upon the potential adoption of grain amaranth production. This analysis is carried out in Chapter 7 and provides a more detailed and accurate picture of grain amaranth adoption in communities which commonly have a high incidence of people living with HIV.

CHAPTER 7
THE IMPACT OF ADULT HIV INFECTION UPON POTENTIAL ADOPTION OF GRAIN AMARANTH BY DIVERSE HOUSEHOLDS IN AMUKURA AND MWATATE

Introduction

Chapter 6 has shown which households potentially adopt grain amaranth as a livelihood strategy under the assumption of no additional stress to a household. In reality, however, households are continually subject to both internal and external stresses. External stresses upon a household include shocks such as war, famine, changes in market supply and demand, and commodity price shifts. Meanwhile, internal stresses upon a household include changes in household composition, sickness and changing social structures and cultural norms. HIV/AIDS is possibly the most influential and devastating internal shock to a household, due especially to its impacts upon labor availability and consumption requirements.

This chapter extends the analysis and discussion of chapter 6 by examining the impact of adult HIV infection upon potential adoption of grain amaranth. This chapter thus uses Research Question 4 as a framework for analysis:

RQ4: What is the impact of HIV/AIDS upon the potential adoption of grain amaranth as a livelihood strategy by diverse households in these communities?

The objective of this research question is to identify the impact of HIV infection upon the potential adoption of grain amaranth between households within each community and between the two communities as a whole. Underpinning this objective is the aim of identifying how potential adoption of grain amaranth is affected if an adult member contracts HIV. Furthermore, this research question explores the difference in potential adoption of grain amaranth between the scenarios of 1) an adult male, or 2) an adult female household member contracting HIV, as well as the difference between

Amukura and Mwatate households' potential adoption of grain amaranth in the context of HIV.

In order to address this research question, ELP was used. The ELP models constructed for Chapter 6 were extended to incorporate the impacts of HIV infection of an adult upon the household. Both socioeconomic data collected from the field and secondary data concerning HIV impacts upon labor availability and consumption requirements were combined and used to construct the HIV ELP models.

This chapter begins by providing a detailed description of the construction of the HIV ELP models, including the different scenarios analyzed and the assumptions incorporated into the models. Following this, there is a discussion of the impacts of HIV infection of an adult upon the potential adoption of grain amaranth for households in Amukura, then for households in Mwatate. In this discussion, the impacts of HIV upon overall food security and end year cash in diverse households in each community are assessed. The discussion then focuses on the impacts of HIV upon grain amaranth adoption for food consumption and upon household diets, followed by focusing on the impacts of HIV upon grain amaranth adoption for sale and upon household sales of other agricultural commodities. The conclusion draws this analysis together by identifying what can be learnt about the differences between the impacts of adult HIV infection upon households in different communities and the differences between the impacts of an adult male or an adult female contracting HIV upon households.

HIV+ Model Scenarios and Assumptions

As described in Chapter 2, the progression of HIV in an individual can be viewed epidemiologically in three main phases - initial infection, clinical latency (asymptomatic), and final. Two HIV+ models were constructed using the AMAR model (Chapter 6) as the

framework and incorporating HIV infection as a dynamic event that has different impacts over time. This AMAR model was adjusted to simulate 1) for an adult male contracting HIV (HIV+ M) and 2) for an adult female contracting HIV (HIV+ F). HIV infection was modeled to occur in year 3, with death of the HIV+ individual at the end of year 9. Year 3 of the model was considered to be the initial phase of HIV infection, years 4-8 considered to be the asymptomatic phase of infection, with year 9 being the final phase resulting in death. Throughout the analysis and discussion in this chapter, model results from the HIV scenarios were directly compared with results from the AMAR scenario, as the HIV scenarios were an extension of the AMAR scenario presented in Chapter 6.

Table 7-1. Multiplication factor adjustment to labor contribution when household member is sick with HIV

HIV+ Household member	HIV phase	Male adult	Female adult	Youth (female)
Male adult	Initial onset (1yr)	0	0.95	
	Asymptomatic (5yrs)	0.9		
	Final stage (1yr)	0	0.8	
Female adult	Initial onset (1yr)		0.3	0.95
	Asymptomatic (5yrs)		0.9	
	Final stage (1yr)		0.2	0.9

These two models incorporated two of the main impacts that occur as a result of HIV infection of a household member – adjustments to available labor, and adjustments to consumption and calorie/protein requirements (Tables 7-1 and 7-2). In the HIV+ M scenario, based on fieldwork observations, an infected adult male was estimated to be unavailable for work in both the initial and final stage of HIV infection. During the asymptomatic phase, it was estimated that the infected male would aim to work as much as possible, but that his total labor contribution would still be reduced by

approximately 10%. Adult female labor was also reduced in this scenario in the initial and final stages to reflect labor diverted to care-giving activities for the infected male. In the HIV+ F scenario, an infected adult female was estimated to still provide approximately 30% of her normal available labor in the initial stage, and 20% of her normal available labor in the final stage of infection (Table 7-1). Although there is no difference in effects of HIV infection between males and female, these different labor estimations were incorporated because unlike adult males, adult females were likely to work some even when sick, as they felt obligated to provide food and care for their households. Similar to the asymptomatic phase under the HIV+ male scenario, the infected adult female was estimated to work as much as possible with an overall reduction in available labor of approximately 10% during this time. Care-giving duties in this scenario would rest with a female youth in the household, as males do not typically contribute labor to care-giving tasks in the household.

Table 7-2. Multiplication factor adjustment to consumption and calorie/protein requirements for household members with HIV for each year

Year	1	2	3	4	5	6	7	8	9	10	11
Multiplication factor	1	1	1.1	1.25	1.1	1.1	1.1	1.1	1.25	0	0

In both scenarios, the HIV+ adult was estimated to increase consumption and calorie/protein requirements between years 3 and 9 (Table 7-2). These increases were estimated at the WHO's recommended 10% level, except for years 4 and 9. In year 4, it was estimated that an adult would need an increase in consumption and calorie/protein requirements of 25% in order to recover from the effects of the initial phase of infection. In year 9, a similar increase was estimated in order for the adult to maintain as decent a quality of life as possible in the final stage. This follows from the suggestions of the de

Waal and Tumushabe (2003) report of greater required increases in consumption for HIV+ individuals than the WHO (2003) report indicated.

Although sixteen household were modeled under the BASIC and AMAR scenarios for both Amukura and Mwatate, not all of these households could be modeled under the HIV+ M scenario. Under this scenario, only twelve (12) households were modeled for each community - households 1 through 4 could not be modeled due to the lack of an adult male in the household to contract HIV.

In terms of feasibility of modeled outcomes for each household, limits were set for possible household consumption reductions. Under these scenarios, households were not permitted to reduce their consumption below 40% of their total consumption requirements for any particular year – it was assumed that if a household reduced its consumption any further than this, then the household would no longer be able to exist as it could not feed itself enough to survive. Indeed, a household may well break up before reaching such limits – estimating the minimum consumption level at which a household can continue to exist is difficult, especially when every household will have a different minimum level. This level of 40% of a household's total consumption requirements for the year was chosen on the assumption that a household would struggle to survive once household members were consistently cutting between half and two-thirds of their daily required calories. Households that could not even meet 40% of minimum consumption requirements for a year were considered to be infeasible, and therefore cease to exist. In such situations, it is likely that the household breaks up or is subsumed within another household.

Impacts of Adult HIV Infection upon Household Food Security

Before analyzing the impacts of HIV infection of adult members upon the potential adoption of grain amaranth within a household, it is important to consider the overall picture of the impacts upon food security in diverse households. These impacts are assessed for each scenario in turn.

HIV+ adult male scenario (HIV+ M)

When an adult male household member contracted HIV, ten out of twelve households were unable to meet either minimum calorie requirements, or minimum protein requirements, or a combination of both (Table 7-3). Only households 14 and 15 remained food secure. Both of these households maintained a low consumer-producer ratio over time, affording them the labor resources to maintain household food security. Household 14 was able to remain food secure as it was a polygamous household with three adult females available to continue to provide necessary food for the household. Household 15 began with two adults and only one child, so when the adult male contracted HIV, the adult female was able to maintain household food security as she did not have to provide any school fees for youths nor provide food for a large number of people in the household.

Out of the ten households unable to meet minimum consumption requirements, five (5, 8, 12, 13 and 16) were unable to meet both calorie and protein requirements, while the other five (6, 7, 9, 10 and 11) were able to meet calorie requirements but unable to meet protein requirements (Table 7-3). The most food insecure time for all of these households was in years 3 and 4 during the initial phase of infection and the year of recovery directly following this phase. Even following the death of the adult male in

year 9, households were not as food insecure as in years 3 and 4. This implies that, when an adult male contracted HIV, the critical time for a household was during the initial phase of infection. If a household could struggle through this initial phase, and assuming a period of a few years of asymptomatic infection, the household was able to plan more effectively to cope following the death of the adult male.

Table 7-3. Amukura households' change in calorie/protein consumption by time period under the HIV+ M scenario compared with the AMAR scenario

Household [1] (composition in years 1-4) [2]	Percentage reduction from minimum requirements under HIV+ M scenario						Percentage reduction under HIV+ M scenario compared with AMAR scenario					
	Calories			Protein			Calories			Protein		
	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10
5 (1-1-0-0-2)	55	0	0	60	0	0	55	0	0	60	0	0
6 (1-1-3-3-1)	0	0	0	20	0	0	0	0	0	20	0	0
7 (1-1-1-1-1)	0	0	0	20	10	0	0	0	0	20	10	0
8 (1-1-1-0-2)	23	0	0	30	0	10	6	0	0	13	0	10
9 (1-2-1-1-2)	0	0	0	9	0	0	0	0	0	9	0	0
10 (2-3-3-2-0)	0	0	0	20	0	0	0	0	0	20	0	0
11 (1-1-0-0-0)	0	0	0	6	0	5	0	0	0	6	0	5
12 (1-1-2-2-4)	30	0	0	40	10	0	1	0	0	11	10	0
13 (2-1-1-0-1)	13	0	0	13	0	0	0	0	0	7	0	0
14 (1-3-0-2-3)	0	0	0	0	0	0	0	0	0	0	0	0
15 (1-1-0-0-1)	0	0	0	0	0	0	0	0	0	0	0	0
16 (1-1-0-1-1)	5	0	0	20	0	0	5	0	0	20	0	0

The three most food insecure households in terms of falling short of both minimum calorie and protein requirements under this scenario were households 5, 8 and 12 (Table 7-3). However, households 8 and 12 were not significantly more food insecure under this scenario than under the AMAR scenario. On the other hand, household 5 was the most food insecure in years 3 and 4 as this was the only household in these years that had not only more than one child but also only one adult and no youths to

[1] See Table 4-3 for the changes in Amukura household compositions for years 5-8 and 9-11.

[2] Household compositions in the format of numbers of (male adult – female adult – male youth – female youth – child)

provide for the household – and therefore a high consumer-producer ratio. Household 5 is a prime example of a young household – a husband and wife with small children. The impact of adult male HIV infection upon this type of household is more severe than upon other types of household as this household does not have the available labor resources to cope with the loss of one of only two members who contribute to the labor pool. In addition, the lack of youths in such a household provides no safety net for care and provision for multiple young children in the household.

All households were able to recover by year 5 and meet minimum calorie requirements. However, four households (7, 8, 11 and 12) failed to meet minimum protein requirements beyond year 4. Households 7 and 12 were unable to meet minimum protein requirements in years 5 through 7. This was due to a combination of factors facing these households in these years, meaning that although the HIV+ adult male had physically recovered by this stage, the household was still feeling the effects of the reduced available cash as a result of the initial phase of infection. In household 7, the child in this household in years 1 through 4 grew up and became a youth in year 5. This household had therefore additional consumption needs and an additional school fees burden from year 5 onwards. Furthermore, this male youth's labor was used more for cash cropping and taking care of livestock than providing legumes – the main protein source for the household – which was typically done by household females. Thus, household 7 was unable to maintain provision of protein at minimum requirements. Meanwhile, household 12 was also faced with a continuing school fees burden for four youths in year 5, as well a continuing high consumer-producer ratio, which resulted in inability to provide enough protein to meet minimum household requirements.

Table 7-4. Change over time of household consumer-producer ratios under the HIV+ M scenario

	Consumer-Producer ratio					
Household (composition in years 1-4)	Yr 2 Pre-HIV infection	Yr 3 Initial infection	Yr 4 Asymptomatic	Yrs 5-7 Asymptomatic	Yr 8 Asymptomatic	Yrs 9-10 Post-death
5 (1-1-0-0-2)	2.23	3.53	2.56	2.34	1.80	2.10
6 (1-1-3-3-1)	1.83	2.08	1.92	1.61	1.50	1.60
7 (1-1-1-1-1)	1.70	2.14	1.86	1.50	1.80	2.10
8 (1-1-1-0-2)	1.63	2.19	1.82	2.27	2.22	2.67
9 (1-2-1-1-2)	1.78	2.10	1.90	1.83	1.41	1.50
10 (2-3-3-2-0)	1.33	1.59	1.44	1.41	1.29	1.33
11 (1-1-0-0-0)	1.00	1.42	1.18	1.68	2.34	3.34
12 (1-1-2-2-4)	2.89	3.55	3.08	2.19	1.85	2.06
13 (2-1-1-0-1)	1.44	2.19	1.70	1.80	1.80	2.10
14 (1-3-0-2-3)	1.88	2.21	1.99	1.72	1.72	1.84
15 (1-1-0-0-1)	1.53	2.26	1.77	1.75	1.80	2.10
16 (1-1-0-1-1)	2.17	3.01	2.42	1.80	1.50	1.60

Following the death of the adult male in year 9, households 8 and 11 were unable to meet protein requirements. These households had the highest consumer-producer ratios in years 8 through 10 (Table 7-4). In terms of specific household composition, these households were the only ones to have two children and only one adult female to care for the children in years 8 through 11. The adult female in these households was unable to make up for the household dietary protein that was lost in year 9 because it had been supplied by the adult male prior his death through cereal production. These households attempted to meet consumption requirements through purchasing food – and they were the households that purchased the most food - but due to limited market availability these households were still unable to meet protein requirements. These two households were therefore the most food insecure following the death of the adult male, implying that households with more children and higher consumer-producer ratios are most vulnerable to food insecurity following the death of an adult male.

HIV+ adult female scenario (HIV+ F)

The impacts upon household food security were in general more severe under the HIV+ F scenario than under the HIV+ M scenario. Every household except household 2 was unable to meet consumption requirements under the HIV+ F scenario. Household 2 had enough adult and youth female labor in years 3 and 4 to continue to provide for the household. In later years, this household had a low consumer-producer ratio, reflected by having no children to provide for, and was able to purchase enough food to meet calorie and protein requirements. At the other extreme, household 4 was not feasible, as it could not even meet 40% of the minimum calorie and protein requirements in years 3 and 4 – this household's consumer-producer ratio was extremely high in years 3 and 4, preventing it from maintaining household food security (Table 7-5). This suggests that this household would no longer exist under this scenario, but would most likely be split up or taken into another household in the community.

Table 7-5. Change over time of household consumer-producer ratios under the HIV+ F scenario

	Consumer-Producer ratio					
Household (composition in years 1-4)	Yr 2 Pre-HIV infection	Yr 3 Initial infection	Yr 4 Asymptomatic	Yrs 5-7 Asymptomatic	Yr 8 Asymptomatic	Yrs 9-10 Post-death
1 (0-2-2-3-1)	1.80	2.24	2.02	1.63	1.58	1.60
2 (0-1-0-2-1)	2.10	2.74	2.38	1.63	1.63	2.00
3 (0-1-1-1-3)	4.01	5.76	4.57	2.21	1.71	2.00
4 (0-1-0-0-2)	4.68	16.27	6.48	2.41	1.63	2.00
5 (1-1-0-0-2)	2.23	2.99	2.56	2.34	1.80	2.10
6 (1-1-3-3-1)	1.83	2.01	1.92	1.61	1.50	1.60
7 (1-1-1-1-1)	1.70	2.00	1.86	1.50	1.80	2.10
8 (1-1-1-0-2)	1.63	1.98	1.82	2.27	2.22	2.67
9 (1-2-1-1-2)	1.78	2.01	1.90	1.83	1.41	1.50
10 (2-3-3-2-0)	1.33	1.60	1.49	1.41	1.29	1.25
11 (1-1-0-0-0)	1.00	1.27	1.18	1.68	2.34	3.34
12 (1-1-2-2-4)	2.89	3.34	3.08	2.19	1.85	2.06
13 (2-1-1-0-1)	1.44	1.64	1.56	1.80	1.80	2.10
14 (1-3-0-2-3)	1.88	2.62	2.22	1.84	1.84	1.84
15 (1-1-0-0-1)	1.53	1.98	1.77	1.75	1.80	2.10
16 (1-1-0-1-1)	2.17	2.71	2.42	1.80	1.50	1.60

Most households used food purchasing as a strategy to increase calorie and protein intake. However, lack of available cash in years 3 and 4 - at the time of and directly following the initial infection of an adult female with HIV - prevented four households (1, 9, 10 and 14) from purchasing food. Households 8, 11, 13 and 15 purchased the most food, predominantly in years 9 and 10 following the death of the adult female, as these households had high consumer-producer ratios, and so had a large proportion of consumers to feed.

Table 7-6. Amukura households' change in calorie/protein consumption by time period under the HIV+ F scenario compared with the AMAR scenario

Household (composition in years 1-4)	Percentage reduction from minimum requirements under HIV+ F scenario						Percentage reduction under HIV+ F scenario compared with AMAR scenario					
	Calories			Protein			Calories			Protein		
	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10
1 (0-2-2-3-1)	6	0	0	20	0	0	6	0	0	20	0	0
2 (0-1-0-2-1)	0	0	0	0	0	0	0	0	0	0	0	0
3 (0-1-1-1-3)	57	0	0	60	10	0	34	0	0	30	10	0
4 (0-1-0-0-2)	Infeasible			Infeasible			N/A	N/A	N/A	N/A	N/A	N/A
5 (1-1-0-0-2)	52	0	34	55	10	41	52	0	34	55	10	41
6 (1-1-3-3-1)	1	0	0	20	0	7	1	0	0	20	0	7
7 (1-1-1-1-1)	26	0	35	40	0	41	26	0	35	40	0	41
8 (1-1-1-0-2)	20	0	0	20	0	0	3	0	0	3	0	0
9 (1-2-1-1-2)	0	0	0	10	0	0	0	0	0	10	0	0
10 (2-3-3-2-0)	0	0	0	20	0	0	0	0	0	20	0	0
11 (1-1-0-0-0)	0	0	26	5	0	31	0	0	26	5	0	31
12 (1-1-2-2-4)	29	0	0	30	0	0	0	0	0	1	0	0
13 (2-1-1-0-1)	13	0	0	13	0	0	0	0	0	0	0	0
14 (1-3-0-2-3)	2	0	0	13	0	0	2	0	0	13	0	0
15 (1-1-0-0-1)	0	0	0	13	0	0	0	0	0	13	0	0
16 (1-1-0-1-1)	4	0	0	20	0	8	4	0	0	20	0	8

Despite most households purchasing some food, fourteen households (every household excluding households 2 and 4) were unable to meet minimum protein consumption requirements, of which eleven were also unable to meet minimum calorie requirements (Table 7-6). Households 3 and 5 were the most food insecure in years 3 and 4 as these households had a combination of smaller than average available land

resources and high consumer-producer ratios. In particular, when the adult female contracted HIV, these households lacked sufficient available female labor to take care of the children in the household. This task was very gender-specific, and so any remaining female labor would be taken away from food production for the household in order to care for the children. This resulted in severe shortages of necessary calories and protein for these households during years 3 and 4, though by year 5 these households were able to recover somewhat and meet calorie requirements and improve protein intake to almost minimum required levels. This was due to the asymptomatic adult female providing labor again by year 4, combined with increasing available cash by year 5 and the changing composition of households 3 and 5 which resulted in lower consumer-producer ratios.

Unlike under the HIV+ M scenario, some households under this HIV+ F scenario were more food insecure following the death of an adult female. This was the case for households 7 and 11, while household 5 returned to almost the same degree of food insecurity it witnessed in years 3 and 4. All three of these households had small land holdings (less than 3.5 acres) and had high consumer-producer ratios in years 9 and 10 following the death of the adult female. First, this implies that households that have small land holdings and high consumer-producer ratios are the most vulnerable to chronic food insecurity following the death of an adult female – even when these households had several years to plan and prepare for the death of the adult female. Secondly, this implies that vulnerable households are more susceptible to chronic food insecurity following the death of an adult female rather than the death of an adult male. This is because the bulk of food production in Amukura culture is located in the female

domain, especially in terms of food preparation and utilization, while cash cropping, such as sugar cane production, and livestock keeping are predominantly in the male domain. Vulnerable households are therefore less able to maintain food security following the loss of adult female labor than the loss of adult male labor.

Impacts of Adult HIV Infection upon Household End Cash

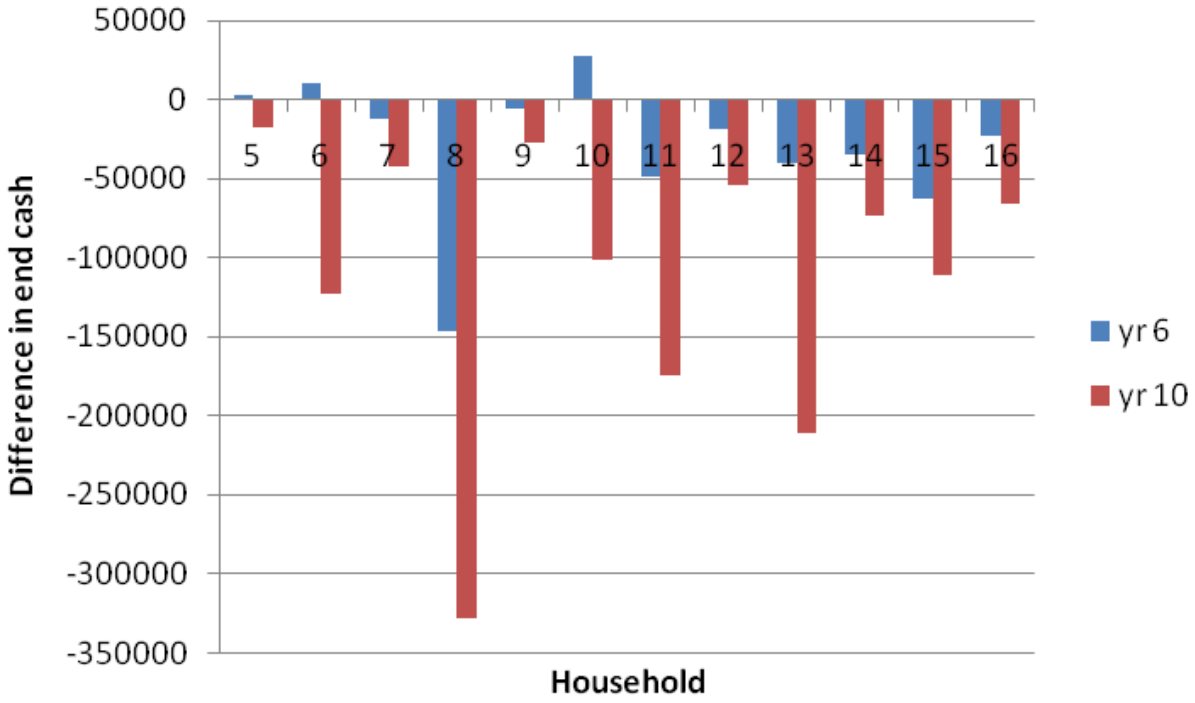

Figure 7-1. Difference in household end cash in year 6 and year 10 between AMAR scenario and HIV+ M scenario

All households under both HIV+ scenarios had reduced end cash in year 10 compared with the AMAR scenario (Figures 7-1 and 7-2). However, HIV infection of an adult member impacted every household's end cash to a different degree dependent upon available resources of land, labor and initial cash at the time of HIV infection (year 3) and the consumption and school fee demands of household members. In some instances – households 5, 6 and 10 under the HIV+ M scenario, and households 1, 6 and 16 under the HIV+ F scenario – household end cash increased slightly by year 6

compared with the AMAR scenario. This is directly related to a reorganization and re-prioritization of cash resources in the face of HIV. These households generated more cash under the HIV scenarios by year 6 either by removing youths from school for a period of time to save cash spent on school fees or by reducing household food intake through spending less on inputs and consequently growing less food.

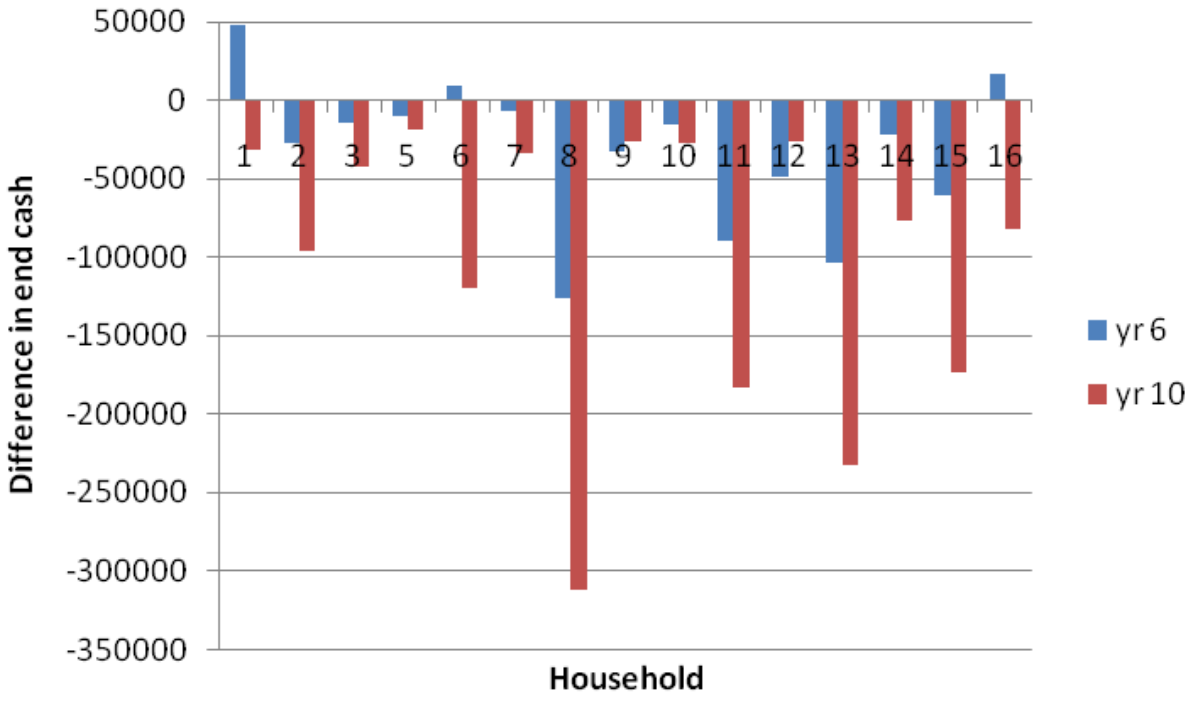

Figure 7-2. Difference in household end cash in year 6 and year 10 between AMAR scenario and HIV+ F scenario

The end cash in year 10 of households 8, 11 and 13 was the most reduced under both HIV+ scenarios compared with the AMAR scenario (Figures 7-1 and 7-2). These three households had the highest consumer-producer ratios following the death of the HIV-infected adult in year 9 (Tables 7-4 and 7-5). Therefore, in years 9 and 10, households 8, 11 and 13 were the ones that had to spend the most cash on purchasing food to help their household try to meet consumption requirements following the devastating loss of an adult member's labor.

For the male-headed households (which were modeled under both HIV+ scenarios), six households (5, 11, 13, 14, 15 and 16) had greater reductions in end cash in year 10 under the HIV+ M scenario while the other six (6, 7, 8, 9, 10 and 12) had greater reductions under the HIV+ F scenario. However, these differences in end cash reductions for households between the two scenarios were generally small. The differences noted were due primarily to the change in available labor resources for these households. The loss of adult male labor was more critical in reducing end cash in year 10 for households 5, 11, 13, 14, 15 and 16. Under this scenario, households 5, 11, 15 and 16 lacked available male labor for continuing cash-generating activities, household 13 lost male labor over time not only due to HIV but also due to males leaving to set up their own households, and household 14 had plentiful female labor so that a loss of male labor due to one male contracting HIV generated more significant impacts upon end cash than the loss of female labor due to one female contracting HIV.

Meanwhile, the loss of adult female labor was more critical in reducing end cash in year 10 for households 6, 7, 8, 9, 10 and 12. The loss of adult female labor due to HIV resulting in a shift of male labor from cash-generating activities towards food production for household consumption reduced end cash in year 10 for these households more than the direct loss of adult male labor due to HIV. This was because all six of these households had more available male labor than female labor, so the loss of female labor due to HIV generated more severe impacts upon end cash than the loss of male labor due to HIV.

Under the HIV+ F scenario, the reduction in end cash in year 10 compared with under the AMAR model for the FHH (households 1, 2 and 3) was in general not as

significant as for the MHH (households 5 through 16). This was because the FHH were not generating as much end cash under the AMAR scenario as the MHH because the FHH were involved predominantly in food production rather than cash generating activities. Therefore, these FHH did not have as much cash to lose compared with the MHH.

Table 7-7. Number of years of youths' schooling lost due to HIV infection of an adult household member in Amukura households between years 2 and 10.

Household (composition in years 1-4)	HIV+ M scenario	HIV+ F scenario
1 (0-2-2-3-1)	-	6
2 (0-1-0-2-1)	-	4
3 (0-1-1-1-3)	-	4
4 (0-1-0-0-2)	-	0
5 (1-1-0-0-2)	3	0
6 (1-1-3-3-1)	0	3
7 (1-1-1-1-1)	0	0
8 (1-1-1-0-2)	2	2
9 (1-2-1-1-2)	7	9
10 (2-3-3-2-0)	0	0
11 (1-1-0-0-0)	0	0
12 (1-1-2-2-4)	4	16
13 (2-1-1-0-1)	0	0
14 (1-3-0-2-3)	4	0
15 (1-1-0-0-1)	0	0
16 (1-1-0-1-1)	0	0

Linked to the loss of end cash was the loss of years of schooling of household youths due to HIV infection of an adult member. HIV infection led to a reduction in available cash for all households, which in turn forced some households to remove their youths from school either for a period of time or indefinitely. This also had the added benefit of increasing a household's available supply of labor. When a household only had to remove some and not all youths from school, the female youths were removed first. Households continued to re-evaluate on an annual basis whether or not to remove youths from school depending on available labor and cash resources. Therefore,

although during times of stress such as years 3, 9 and 10, some households had to remove youths from school, during the asymptomatic period, these same households were often able to send their youths back to school.

More schooling years were lost under the HIV+ F scenario than under the HIV+ M scenario, implying that in terms of formal education for youths, it is worse in Amukura when a household adult female contracts HIV than when an adult male contracts HIV. These findings suggest that the loss of labor for food production activities of a household (typically done by an adult female) has a more significant impact on keeping youths in formal education than the loss of labor and subsequent cash generated from cash-generating activities of a household (typically done by an adult male).

The households that lost the most years of youth education were the FHH (1, 2 and 3) under the HIV+ F scenario, and households 9 and 12 under both scenarios (Table 7-7). The FHH were more severely impacted due to the lack of adults in their households, forcing them to need to use youth labor for agricultural activities once the adult female contracted HIV. Households 9 and 12 were also severely impacted as they had a high number of youths in their households – it was expensive for these households to keep all the youths in school once an adult member contracted HIV, and the youth labor was required for agricultural activities for the household.

Impacts of Adult HIV Infection upon the Potential Adoption of Grain Amaranth Production for Consumption

HIV+ adult male scenario

Overall, grain amaranth production for consumption was adopted by households in Amukura to a lesser extent under the HIV+ M scenario than with the AMAR scenario. Only six households adopted grain amaranth production for consumption under the

HIV+ M scenario, compared with nine households under the AMAR scenario. However, when looking in more detail, adult male HIV infection impacted the production of grain amaranth for consumption in diverse households in different ways. Under the HIV+ M scenario, households 6, 10, 12 and 16 no longer adopted grain amaranth production for consumption from the time of initial infection in year 3, and households 5, 7 and 13 all reduced their consumption of grain amaranth to different degrees while still consuming some (Table 7-8). Meanwhile, households 8 and 15 increased production of grain amaranth for consumption and household 11 was the only household that adopted grain amaranth production for consumption for the first time under this scenario.

Table 7-8. Total consumption of grain amaranth (bags) for years 2-10 for Amukura households under the HIV+ M scenario

Household (composition in years 1-4)	Year									
	2	3	4	5	6	7	8	9	10	Total
5 (1-1-0-0-2)	4.57	0	0	0	0	0	0	2.13	0	6.70
7 (1-1-1-1-1)	0.93	0	0	0	0	0	0	1.77	0	2.70
8 (1-1-1-0-2)	3.98	4.05	2.74	4.79	4.51	4.78	0	0	0	24.86
11 (1-1-0-0-0)	0	0	0	0	0	0	0	1.62	0	1.62
12 (1-1-2-2-4)	2.79	0	0	0	0	0	0	0	0	2.79
13 (2-1-1-0-1)	7.33	5.32	2.54	0	0	0	0	0	0	15.20
15 (1-1-0-0-1)	0.37	1.28	0	0	0	0	0	1.28	0	2.93

Therefore, the loss of adult male labor due to HIV infection impacted the decisions these households made concerning grain amaranth production for consumption in different ways, dependent on the resources available to each household. For those seven households (5, 6, 7, 10, 12, 13 and 16) that decreased their overall consumption of grain amaranth, much of this decrease occurred during the asymptomatic phase of HIV infection (years 4 through 8). The reduction in available adult male labor coupled with the reductions in end cash for these households meant that grain amaranth

production for consumption was no longer an attractive livelihood activity during the asymptomatic phase due to the relative cost of grain amaranth inputs and grain amaranth's relatively intensive labor requirements in comparison to other grains.

However, during times of acute stress such as the initial stage of HIV infection (year 3) and following the death of the HIV infected adult male in year 9, grain amaranth production for consumption increased for six households. In year 3, grain amaranth production for consumption increased for households 8, 13 and 15. Households 8 and 13 were the two households that were the most food insecure under the AMAR scenario. Therefore, in year 3 these households increased grain amaranth production for consumption as a means to help maintain household protein intake. Household 15 was one of the households with the least amount of combined land and labor resources in year 3, having only 2.5 acres of land, and no youth labor. Meanwhile, household 15 did have enough starting cash to purchase the relatively expensive grain amaranth seed to plant. Other households did not adopt grain amaranth for production in year 3 as they were not under as much stress in terms of available land and labor resources as households 8, 13 and 15, nor did they have sufficient starting cash resources to purchase grain amaranth seed.

In year 9, households 5, 7, 11 and 15 all increased grain amaranth production for consumption (Table 7-8). Year 9 was a more important time for grain amaranth production for consumption due to the reduction of adult male labor. Even though households could prepare for the death of the adult male, the shock of his death in year 9 increased the stress on these four households (5, 7, 11 and 15) to the point at which grain amaranth production for consumption was adopted as a livelihood activity. The

sudden loss of adult male labor forced these households to look for a quick solution to meet their minimum consumption requirements. As grain amaranth is the quickest grain crop to reach harvest, and because these households had enough starting cash in year 9 to purchase grain amaranth seed, grain amaranth production for consumption was a viable livelihood strategy to help them mitigate the impacts brought about by the death of an adult male.

In year 10, although all households were under stress having lost an adult male, no household produced grain amaranth for consumption. By this year, households that had previously grown grain amaranth were able to restructure their livelihood activities to reflect their available resources. With the reduction in adult male labor, activities such as sorghum, finger millet and legume production that required a greater proportion of female labor were chosen in preference to grain amaranth production.

Seasonal grain amaranth production for consumption under the HIV+ M scenario also varied significantly among households. Except for household 15, all other households that consumed grain amaranth produced the most bags in the August-October season, followed by the February-April season, and with the May-July season seeing the lowest production on average (Figure 7-3). The August-October season saw the highest production because households were trying to meet consumption requirements for the end of the year at the same time as generating as much cash as possible to meet end of the year cash requirements. Grain amaranth was an activity used by these households to simultaneously help them meet both consumption and cash requirements – this is shown in more detail in the discussion of grain amaranth sales.

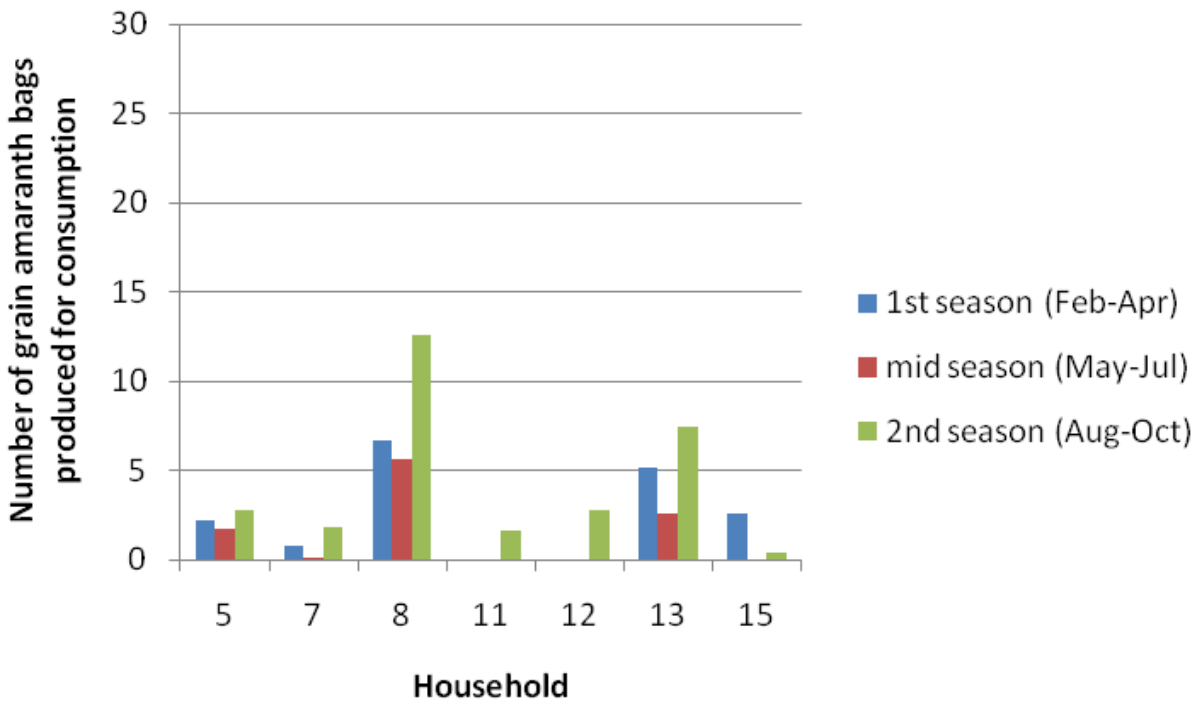

Figure 7-3. Total number of grain amaranth bags produced for consumption by season between years 2 and 10 for Amukura households under the HIV+ M scenario

The mid-season (May-July) saw the lowest production of grain amaranth for consumption as land and labor were generally utilized to the maximum at this time of year – labor was tied up with harvesting and post-harvest activities for first season crops and with land preparation for second season crops, while land was tied up with crops that required more days to reach harvest than grain amaranth. Land that had just been used for the previous grain amaranth crop was not re-planted immediately with grain amaranth due to the high nutrient demands that amaranth places on the soil. Household 15 was the only exception to this seasonal pattern of production, with higher production of grain amaranth in the February-April season than in the August-October season. This was because this household was able to generate cash from first season plantings of grain amaranth which was then invested in production of other crops in the second

season which were needed to help the household meet consumption and cash requirements.

Changes in diets of Amukura households under the HIV+ adult male scenario

The contraction of HIV by an adult male household member brought about widespread impacts not only upon the potential adoption of grain amaranth for consumption but also upon the overall consumption strategies adopted by households. By examining the changes in dietary choices made by these diverse households, a more in-depth understanding of the changes in patterns of grain amaranth production for consumption can be generated.

With the reduction in adult male labor due to HIV, all households except household 13 increased their consumption of sorghum (Table 7-9). Consumption of sorghum provided households with higher protein intake per kg than maize or finger millet, though lower protein levels than grain amaranth. Sorghum is a crop in the female domain, as women are responsible for harvesting and post-harvest sorghum activities. Sorghum is also a relatively cheap crop to produce, with cheaper seeds and less intensive labor requirements than maize or grain amaranth. Therefore, under the HIV+ M scenario, many households replaced much of their consumption of maize and/or grain amaranth with sorghum. In addition, in instances where available cash was a limiting factor, two households (11 and 13) also shifted toward finger millet production under this scenario. Finger millet required the least labor investment of all grain crops, and was cheap to produce, yet yields were typically low so it was not as commonly produced as other crops. However, under this stressful scenario, finger millet started to become a viable livelihood strategy option.

All households (also except household 13) reduced their consumption of both cassava and vegetables, two of the essential components of the Amukura diet. The reduction in available adult male labor meant that these households were no longer able to supply as much of these foods under this scenario as under the AMAR scenario. Meanwhile, household 13 was an exception among all households and was the only household to significantly reduce its sorghum consumption, increase maize consumption and increase cassava and vegetable consumption. This household was already unable to meet minimum consumption requirements under the AMAR scenario. Under the HIV+ M scenario, therefore, this household continued to struggle to meet consumption requirements, and the reduction in available adult male labor caused this household to shift female labor away from sorghum production to cassava, vegetable and legume production, while shifting its remaining available male labor away from cash cropping activities and towards grain production (primarily maize) for consumption.

Although in general most households reduced their consumption of legumes under the HIV+ M scenario, half of the households switch the majority of their legume production from groundnuts to beans (Table 7-9). This was because beans were almost always intercropped with maize while groundnuts were solecropped – thus, producing beans for consumption rather than groundnuts saved both land and labor for households. The households that adopted this switch were ones that were more resource-poor than other households in Amukura. On the other hand, households that had plentiful available female labor and/or plentiful available cash switched from beans to groundnut production for consumption in attempts to continue to meet household minimum consumption requirements.

Table 7-9. Change in total consumption of various foods (bags) between HIV+ M scenario and AMAR scenario for years 3-10 for Amukura households

Household (composition in years 1-4)	Maize	Sorghum	Millet	Amaranth	Beans	Ground nut	Cassa va	Vegeta bles
5 (1-1-0-0-2)	-6.20	3.67	0.00	-5.56	-0.98	0.33	-8.18	-0.98
6 (1-1-3-3-1)	-1.30	5.24	0.00	-8.62	-0.57	-0.46	-7.48	-0.90
7 (1-1-1-1-1)	1.74	5.95	0.00	-12.39	1.94	-2.28	-9.14	-1.10
8 (1-1-1-0-2)	-34.14	22.53	0.00	1.37	-1.27	-0.26	-4.46	-0.84
9 (1-2-1-1-2)	-0.03	1.30	0.00	0.00	0.00	-1.80	-3.17	-0.38
10 (2-3-3-2-0)	-29.27	16.22	0.00	-3.26	-1.89	1.68	-9.70	-1.16
11 (1-1-0-0-0)	-12.94	3.51	1.16	1.62	0.52	-0.88	-5.11	-0.37
12 (1-1-2-2-4)	-29.52	22.71	0.00	-2.86	0.25	-0.42	-2.20	-0.25
13 (2-1-1-0-1)	13.79	-10.65	3.69	-0.57	-0.15	0.28	2.23	0.35
14 (1-3-0-2-3)	-6.43	3.50	0.00	0.00	0.23	0.38	-0.62	-0.05
15 (1-1-0-0-1)	-14.87	6.73	0.00	2.56	0.87	-0.38	-0.63	-0.05
16 (1-1-0-1-1)	-11.17	5.20	0.00	-2.40	0.84	-0.32	-5.48	-0.66

HIV+ adult female scenario

The potential for adoption of grain amaranth production for consumption was significantly higher under the HIV+ F scenario than under either the HIV+ M scenario or the AMAR scenario. Not only did more households adopt grain amaranth for consumption under the HIV+ F scenario, but these households also produced larger quantities of grain amaranth for consumption. Thirteen out of sixteen households adopted grain amaranth for consumption under this scenario, in comparison to six under the HIV+ M scenario and nine under the AMAR scenario. There was higher and more widespread grain amaranth production for consumption under the HIV+ F scenario because the reduction in available adult female labor was critical in undermining the food security of households, as adult females were in charge of food production for the household. As Amukura households struggled more under the AMAR scenario to provide protein rather than calories in their household diets, under this HIV+ F scenario, the reduction in adult female labor forced households to change their food production

activities away from lower protein crops (such as maize) towards grain amaranth which provided higher protein levels for household members. Furthermore, the reduction in available adult female labor forced these households to shift the focus of available male and youth labor away from cash generating activities and towards food production for the household. As grain amaranth is a food crop that is not exclusively in the female domain, household males focused their labor on the production of grain amaranth rather than sorghum or finger millet for household food production.

Table 7-10. Total consumption of grain amaranth (bags) for years 2-10 for Amukura households under HIV+ F scenario

Household (composition in years 1-4)	Year									
	2	3	4	5	6	7	8	9	10	Total
2 (0-1-0-2-1)	0	0	0	0	0	0	0	3.62	0	3.62
3 (0-1-1-1-3)	0	1.09	0	0	0	0	0	0	0	1.09
5 (1-1-0-0-2)	2.89	2.30	0.58	1.14	0.60	0.59	0.44	6.51	0	15.06
6 (1-1-3-3-1)	0	4.20	0	3.68	1.06	2.68	0	8.20	1.20	21.04
7 (1-1-1-1-1)	0.93	0.92	0	6.05	5.57	5.89	2.36	6.51	0	28.24
8 (1-1-1-0-2)	3.98	5.20	6.95	10.12	9.57	10.41	0	11.19	2.75	60.20
9 (1-2-1-1-2)	0	1.52	0	0	0	0	0	5.78	0	7.30
11 (1-1-0-0-0)	0	1.89	0	0	0	0.56	0	5.03	2.49	9.97
12 (1-1-2-2-4)	2.79	4.90	4.48	5.33	4.85	8.09	2.42	13.70	4.33	50.90
13 (2-1-1-0-1)	7.33	8.66	8.55	1.91	0.51	0	0	5.48	0	32.44
14 (1-3-0-2-3)	0	0	0	0	0	0	0	7.28	0	7.28
15 (1-1-0-0-1)	0.37	3.16	0.62	0	0	0	0	9.68	6.48	20.32
16 (1-1-0-1-1)	0	2.19	0	2.43	0.38	1.91	0	7.81	3.70	18.41

Households 8 and 12 consumed the most grain amaranth under the HIV+ F scenario (Table 7-10). Household 8 consumed the most grain amaranth under the AMAR scenario – the additional stress on this household of the reduction in available female labor served to increase this household's reliance on grain amaranth consumption. Household 12 had the largest absolute increase in grain amaranth consumption under the HIV+ F scenario compared with the AMAR scenario. This

household had one of the most consistently high consumer-producer ratios under this scenario, with an especially high number of children to feed. The reduction in available adult female labor therefore hit this household more severely than others, leading it to choose grain amaranth production for consumption as the best option for maintaining household food security.

The three households that did not adopt grain amaranth production for consumption under the HIV+ F scenario were households 1, 4 and 10. Household 4 (a FHH) was infeasible under this scenario. Of the other FHH, households 2 and 3 consumed only a little grain amaranth, while household 1 did not consume grain amaranth. This was because these households lacked available adult male labor, and were therefore still dominated by adult female labor, especially during the asymptomatic phase. During this phase, these households therefore both continued to maintain legume cropping to provide household protein and switched to low-input sorghum production rather than grain amaranth, as sorghum production was in the female domain. The only years that households 2 and 3 produced grain amaranth for consumption were years 3 and 9 (at times of most stress) when these households had to rely primarily on youth labor (Table 7-10). Only during these years was grain amaranth considered a viable alternative to help maintain FHH food security.

Household 10 was only food insecure during years 3 and 4 under the HIV+ F scenario (Table 7-6). This household had 3 adult females, and so even with one adult female contracting HIV, there was still enough adult female labor to maintain the same agricultural activities under this scenario as under the AMAR scenario. Furthermore, due to the high number of youths in the household, this household had high school fee

requirements. Therefore, this household did not have the available necessary cash in its years of stress (years 3 and 4) to purchase expensive grain amaranth seed to invest in grain amaranth production for consumption.

For the households that did adopt grain amaranth, the years of highest grain amaranth production for consumption were years 3, 9 and 10 – at times of acute household stress due to the impacts of HIV. For eleven of these households, their highest consumption of grain amaranth was in year 9, following the death of an adult female. The death of an adult female triggered an urgent need to switch household food production activities towards grain amaranth as it was a crop that could provide food quickly due to its relatively short time to harvest in comparison to other grain crops. However, in year 10, no household maintained grain amaranth consumption at year 9 levels, even though these households had all experienced the death of an adult female. Instead, households restructured their livelihood activities to reflect their new labor composition and available resources of cash and land. A different set of households emerge in year 10 from the set in year 2 of those households that consume grain amaranth. All households that continued to produce grain amaranth for consumption in year 10 were low on available cash and still struggling from the loss of available adult female labor. However, unlike under the HIV+ M scenario, more households maintained grain amaranth production for consumption through the asymptomatic period under this HIV+ F scenario. Households 5, 6, 7, 8, 12, 13 and 16 all had significant grain amaranth production for consumption in years 4 through 8 (Table 7-10). The stress of reduced available adult female labor during this asymptomatic phase was enough to push these seven households into maintaining grain amaranth production for consumption.

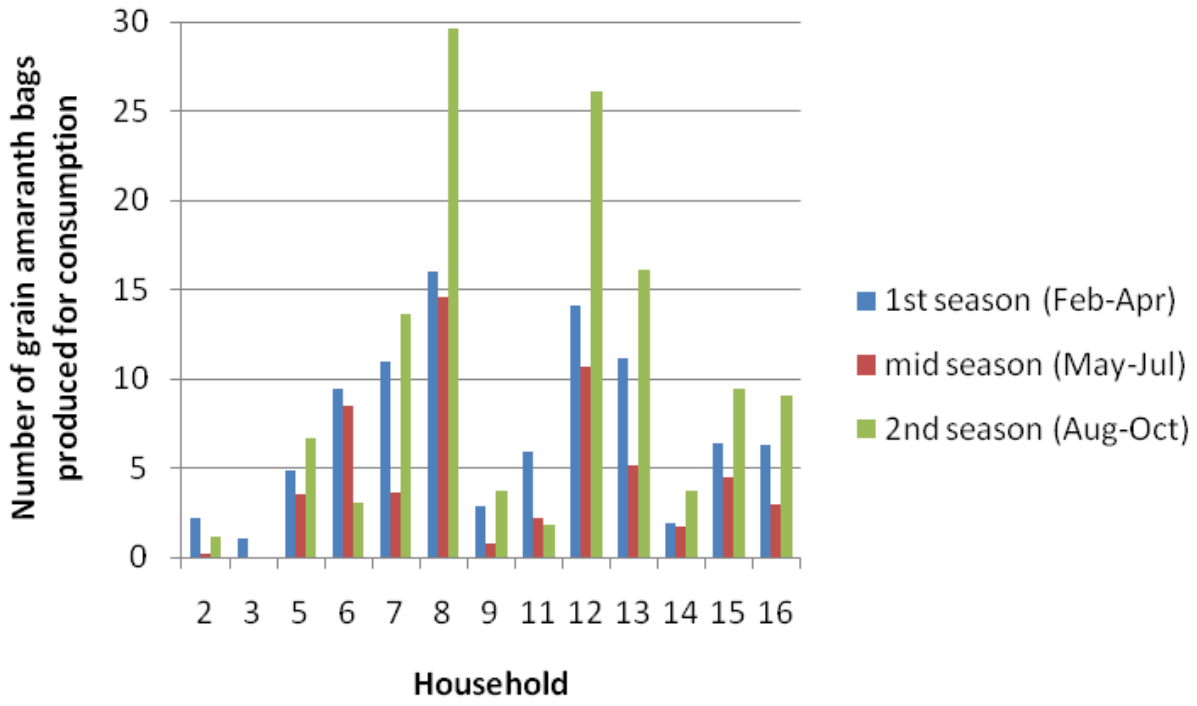

Figure 7-4. Total number of grain amaranth bags produced for consumption by season between years 2 and 10 for Amukura households under the HIV+ F scenario

The seasonal pattern of grain amaranth production for consumption under the HIV+ F scenario, however, was similar to that under the HIV+ M scenario – households consumed the most amaranth in the August-October season, followed by the February-April season, with the May-July season being the season of the lowest grain amaranth consumption (Figure 7-4). Similar to the HIV+ M scenario, households consumed the most grain amaranth in the August-October season in order to try to meet end year consumption requirements, while during the intermediate (May-July) season land and labor were typically tied up for other cropping activities.

However, four households (2, 3, 6 and 11) consumed the most grain amaranth during the first (February-April) season (Figure 7-4). Households 2 and 3 (FHH) only produced grain amaranth at times of acute stress, and this was in the first (February-April) season in year 3 or year 9. By later in the year, these households had

restructured their livelihood activities and grain amaranth was no longer produced for consumption. Meanwhile, households 6 and 11 had sufficient available labor to generate enough available cash from first season livelihood system sales to switch from grain amaranth production in the first (February-April) season to an expansion of maize production in the second (August-October) season.

Changes in diets of Amukura households under the HIV+ adult female scenario

As under the HIV+ M scenario, the contraction of HIV by an adult female household member also brought about widespread impacts not only upon the potential adoption of grain amaranth for consumption but also upon the overall consumption strategies adopted by households. When an adult female contracted HIV, all households shifted their grain production for consumption away from maize and towards grain amaranth and, in some instances, also sorghum (Table 7-11). Those that increased their consumption of sorghum were either FHH (households 1, 2 and 3), those that had additional available adult female labor (households 10 and 14) or those that had consistently low available resources of land, labor, cash or some combination of the three (households 5, 12 and 15). This was because sorghum production is in the female domain and also requires lower cash and labor inputs for production than either maize or grain amaranth. Finger millet continued to be produced only by FHH, but changes in its production for consumption depended upon the household. Household 2 increased finger millet consumption in year 10 when the household remained with one female youth as its only available female labor – finger millet required the least labor and cash investment of all grain crops. On the other hand, household 3 decreased finger millet consumption because it had enough cash in years 3 and 4 to switch to

sorghum and grain amaranth production for consumption, which held better prospects for helping the household meet protein and calorie requirements.

Table 7-11. Change in total consumption of various foods (bags) between HIV+ F scenario and AMAR scenario for years 3-10 for Amukura households

Household (composition in years 1-4)	Maize	Sorghum	Millet	Amaranth	Beans	Groundnut	Cassava	Vegetables
1 (0-2-2-3-1)	-9.59	2.89	0.00	0.00	0.00	-0.27	-4.10	-0.49
2 (0-1-0-2-1)	-10.23	4.37	0.71	3.62	0.54	-0.55	0.00	0.00
3 (0-1-1-1-3)	-22.91	7.11	-1.39	1.09	0.00	-1.01	-10.25	-1.23
5 (1-1-0-0-2)	-27.11	0.79	0.00	2.80	-0.77	-1.25	-21.38	-2.52
6 (1-1-3-3-1)	-5.41	-18.59	0.00	12.42	-0.57	-1.22	-11.11	-1.27
7 (1-1-1-1-1)	-34.52	0.00	0.00	13.15	2.87	-4.12	-18.45	-2.09
8 (1-1-1-0-2)	-41.66	0.40	0.00	36.71	-0.03	-2.04	-3.84	-0.47
9 (1-2-1-1-2)	-7.92	0.00	0.00	7.30	0.00	-1.34	-0.43	-0.05
10 (2-3-3-2-0)	-8.83	1.91	0.00	-3.26	-1.12	1.50	-5.90	-0.71
11 (1-1-0-0-0)	-25.53	0.00	0.00	9.97	1.30	-2.47	-11.84	-1.78
12 (1-1-2-2-4)	-73.68	10.89	0.00	48.04	0.89	-1.05	5.74	0.93
13 (2-1-1-0-1)	-1.26	-12.89	0.00	16.67	0.61	-0.60	3.04	-0.34
14 (1-3-0-2-3)	-24.80	3.73	0.00	7.28	0.00	1.75	-2.52	-0.30
15 (1-1-0-0-1)	-31.74	2.24	0.00	19.95	0.76	-2.01	-7.74	-1.39
16 (1-1-0-1-1)	-29.43	-0.15	0.00	16.01	2.41	-2.53	-6.85	-0.67

The pattern of reduction in other food items – cassava, vegetables and legumes - was similar to that witnessed under the HIV+ M scenario, although the severity of reductions was worse under this HIV+ F scenario as the production of these items for consumption rested primarily in the female domain and was therefore highly dependent on the availability of adult female labor (Table 7-11). All households reduced their production of cassava and vegetables for consumption, except for households 12 and 13, which shifted available male labor from maize and/or sorghum production to cassava and vegetable production in order to help their households meet consumption requirements.

Meanwhile, households either switched their legume production for consumption between beans and groundnuts or simply reduced their legume production for consumption. Households 2, 7, 11, 12, 15 and 16 all switched much of their groundnut production for consumption to beans, as these households no longer had enough labor or cash to produce the same quantity of groundnuts as under the AMAR scenario. Meanwhile, household 10 still had plenty of available adult female labor and so switched legume production from beans to groundnuts in years in which maize-bean intercrops had been replaced with solecropped grains and legumes. For the remaining eight households, legume production for consumption was reduced either in beans, groundnuts or both.

Impacts of Adult HIV Infection upon the Potential Adoption of Grain Amaranth for Sale

HIV+ adult male scenario

All households adopted grain amaranth production for sale, implying that grain amaranth was more attractive as a cash crop than a food crop under the HIV+ M scenario (Table 7-12). Changes in the adoption of grain amaranth production for sale under this scenario when compared with the AMAR scenario were due to the additional stress that HIV infection of an a adult male brought upon a household. There were therefore changes either at times of acute stress due to initial infection or death, or during the asymptomatic phase due to reduction in available male labor which led to changes in the amount of available cash each household had to invest in grain amaranth production for sale.

Households 9 and 14 – the two households that did not adopt grain amaranth production for sale under the AMAR scenario – both sold grain amaranth under the

HIV+ M scenario, thus representing an increase in the total number of households selling grain amaranth. These households sold grain amaranth in years 3 and 4 – the time during and immediately following the initial infection of an adult male. These households had the cash to invest in grain amaranth production for sale because the reduction in available male labor forced these households to remove youths from school thereby increasing both available cash and labor. The cash saved from not having to pay school fees was then invested in grain amaranth production for sale, as this was the best option for these households to obtain a quick investment return. The reduction in available adult male labor also forced household 7 to remove youths from school during the initial phase of infection. However, it was not until the asymptomatic phase that this household had enough available cash to invest in increasing grain amaranth production for sale.

Table 7-12. Total sales of grain amaranth (bags) for years 2-10 for Amukura households under the HIV+ M scenario

Household (composition in years 1-4)	Year									
	2	3	4	5	6	7	8	9	10	Total
5 (1-1-0-0-2)	5.69	7.36	1.69	3.78	0	2.28	0	1.05	0	21.86
6 (1-1-3-3-1)	6.71	5.80	1.54	3.37	0.79	1.78	1.59	1.37	0	22.95
7 (1-1-1-1-1)	1.65	1.98	0	5.34	2.76	7.53	0.13	1.56	0	20.95
8 (1-1-1-0-2)	18.75	7.49	13.45	12.90	10.08	15.22	4.93	0.23	0	83.05
9 (1-2-1-1-2)	0	3.34	0.30	0	0	0	0	0	0	3.64
10 (2-3-3-2-0)	0	0.84	0	0.66	0	1.60	0	0	0	3.10
11 (1-1-0-0-0)	0.25	0	0.97	1.38	0.32	0.87	0.08	0	0	3.87
12 (1-1-2-2-4)	7.72	11.02	4.26	7.95	4.23	7.84	0.27	4.31	0	47.59
13 (2-1-1-0-1)	14.41	8.73	13.87	1.32	0.27	1.15	0	0	0.22	39.98
14 (1-3-0-2-3)	0	7.85	0	0	0	0	0	0	0	7.85
15 (1-1-0-0-1)	2.45	0.19	0.64	0	0	0	0	1.25	0	4.53
16 (1-1-0-1-1)	0	3.37	0.09	1.77	0	1.35	0	0	0	6.58

Households 8 and 16 were the only other households to significantly increase sales of grain amaranth. Once again, these households were able to do this because

they had enough cash to invest in grain amaranth as a cash crop – in the initial phase of infection for household 16, and in the asymptomatic phase for household 8. These households had enough cash even without further removals of youths from school.

However, not every household increased their sales of grain amaranth under the HIV+ M scenario. Households 6, 10, 11 and 13 all reduced their sales of grain amaranth due to the same reasons that caused other households to increase their sales. These households still had enough cash to keep the same number of youths in school under this scenario as under the AMAR scenario. Thus, the reduction in available male labor in these four households led to an overall reduction in available cash to invest in crop production for sale, including grain amaranth.

There was no significant change in pattern of the most important time period (years 2-4, 5-7 or 8-10) for the selling of grain amaranth by each household. The majority of households continued to sell the most grain amaranth in years 2 through 4, with households 7, 8 and 11 selling the most grain amaranth during years 5 through 7. In general, grain amaranth sales increased for households under the HIV+ M scenario only when times of stress coincided with increased available cash for grain amaranth production for sale.

The loss of an adult male in year 9 did not result in an increase in sales of grain amaranth in year 10. In fact, household 13 was the only household to sell grain amaranth in year 10, and even its amount sold was very small (Table 7-12). Therefore, even if HIV infection of an adult male increased sales of grain amaranth for some households, the subsequent loss of adult male labor in year 9 did not bring about any significant increase in grain amaranth sales. This was because male labor typically

focused on cash generating activities – the loss of some or even all of this labor therefore did not lead to increases in cash generating activities such as grain amaranth production for sale.

Although there were no discernable changes in the annual patterns of grain amaranth sales, there were changes in the seasonal patterns. Ten out of twelve households increased their sales of grain amaranth in the intermediate (May-July) season under this scenario when compared to the AMAR scenario (Table 7-13). Under the stress of an adult male being infected with HIV, this intermediate season became very useful for households that had the cash, labor and land available to squeeze in an additional cropping cycle of grain amaranth to generate cash. This highlights the advantage of grain amaranth being a crop that can take as little as 60 days to harvest under Kenyan conditions. In comparison, many households reduced their sales of grain amaranth in the first (February-April) and second (August-October) seasons under the HIV+ M scenario. This was due to households no longer having enough available labor, and consequently available cash, to maintain sales of grain amaranth at levels under the AMAR scenario. The exceptions to this were those five households (7, 8, 9, 14 and 16) that increased grain amaranth sales under the HIV+ M scenario. Households 7 and 8 were able to significantly increase their sales of grain amaranth during the August-October season during the asymptomatic phase of infection as they had enough available cash. Households 9, 14 and 16 were able to increase their sales of grain amaranth during the February-April season in years 3 and 4, when these households were under severe stress due to reduction in available male labor.

Table 7-13. Comparison of seasonal sales of grain amaranth by Amukura households (total bags sold years 2-10) under the HIV+ M scenario with sales under the AMAR scenario

Household (composition in years 1-4)	Total under HIV+ M			Change in sales (HIV+ M minus AMAR scenario)		
	Feb-Apr	May-Jul	Aug-Oct	Feb-Apr	May-Jul	Aug-Oct
5 (1-1-0-0-2)	11.46	3.62	6.77	-1.44	0.50	2.80
6 (1-1-3-3-1)	10.28	9.22	3.45	-9.75	5.77	-7.28
7 (1-1-1-1-1)	7.34	2.37	11.24	0.87	-0.15	7.99
8 (1-1-1-0-2)	32.87	28.33	21.85	-3.60	25.78	6.68
9 (1-2-1-1-2)	3.47	0.17	0	3.47	0.17	0
10 (2-3-3-2-0)	0.84	2.26	0	-1.70	2.26	-2.54
11 (1-1-0-0-0)	0.56	3.31	0	-1.80	3.31	-2.35
12 (1-1-2-2-4)	27.34	14.51	5.75	-2.88	14.51	-9.87
13 (2-1-1-0-1)	20.78	15.08	4.12	-8.51	7.10	-7.12
14 (1-3-0-2-3)	6.37	0	1.48	6.37	0	1.48
15 (1-1-0-0-1)	2.66	1.23	0.64	0.37	1.23	-1.65
16 (1-1-0-1-1)	4.45	1.31	0.82	3.38	1.31	-0.25

Changes in sales of agricultural commodities of Amukura households under the HIV+ adult male scenario

Under the HIV+ M scenario, there is a widespread shift among Amukura households away from the sale of most agricultural commodities including legumes, sugar and/or other grains, and milk, and towards increasing sales of grain amaranth. This shift can be explained by the fact that grain amaranth promised Amukura households some of the best returns for cash investment over a short period of time. Grain amaranth production for sale held the advantages of high sales price and a short time from planting to harvest. Also, grain amaranth was not classified as either a male or female specific crop, and was therefore sold by both men and women. However, not all households shifted to grain amaranth sales, as grain amaranth production is highly resource-demanding. Grain amaranth production not only requires significant initial cash investment due to the high price of seed, but is also labor-intensive and requires land to

be rotated and thus readily available to maintain production through multiple seasons. Households such as 6, 10, 11 and 13 that did not have such resources available were unable to expand grain amaranth production and increase sales (Table 7-14).

Table 7-14. Change in household cash (Kshs) obtained from sales of various agricultural commodities between HIV+ M scenario and AMAR scenario

Household (composition in years 1-4)	Amaranth	Other grains	Legumes	Cassava	Sugar	Beer	Milk	Cow
5 (1-1-0-0-2)	6545	-27338	-19694	1527	-39838	1384	-40198	-340
6 (1-1-3-3-1)	-39445	-42821	-19383	3300	-71923	2326	-19542	-2602
7 (1-1-1-1-1)	30483	-33417	-48586	1800	-113189	3025	-18750	-3588
8 (1-1-1-0-2)	132951	70148	-72853	-20424	-756264	-4504	-56270	-1302
9 (1-2-1-1-2)	12744	-93482	-62690	1150	11902	12779	-65655	-8477
10 (2-3-3-2-0)	-6898	-107405	-50592	0	93672	-12215	-17667	-4129
11 (1-1-0-0-0)	-2940	-126	-44952	5377	-52623	309	-75744	8240
12 (1-1-2-2-4)	6091	-28872	-57628	3530	-231282	-1104	-18750	-2886
13 (2-1-1-0-1)	-29856	-5815	-69251	6887	-269098	0	-74766	9912
14 (1-3-0-2-3)	27473	-71647	-59351	0	0	-818	-46707	-7689
15 (1-1-0-0-1)	4083	185	-23373	0	-243770	-6553	-19516	-2546
16 (1-1-0-1-1)	15157	-7074	-19408	425	-252900	-9947	-19494	-882

The shift towards an increase in grain amaranth sales can also be explained by the factors driving households away from selling other agricultural commodities under the HIV+ M scenario. Legume sales were reduced by all households under this scenario, as legumes were in the female domain. As households are pressured into an increasing focus on maintaining food production, available female labor is concentrated upon production for consumption and less on selling surplus of food crops that are in the female domain, especially legumes. Available male labor was also concentrated less on production for sale and more on helping females in food production activities. Therefore, sales of maize reduced for ten out of twelve households, and sugar sales were reduced by all households except households 9 and 10, which were not under as much stress as other households under this scenario so were able to expand sugar

production. As sugar cane is a long-term investment for a household (at least 18 months), when under the stress of an adult male contracting HIV, households turned towards activities that could generate a faster return on their investment. Sales of milk were reduced as female labor was required to focus on food production for the household and because in many instances, cows were sold by a household in times of urgent need of cash, such as during years 3, 9 and 10. The only agricultural commodity under this scenario that also experienced a widespread increase in sales apart from grain amaranth was cassava, which was sold primarily in root form as this was easier to store than processed flour, which required bags for storage. This was because cassava was cheap to produce and required a low intensity of labor, ideal for households under stress.

HIV+ adult female scenario

The pattern of household adoption of grain amaranth production for sale under the HIV+ F scenario was similar in some respects but different in others compared to under the HIV+ M scenario. Similar to the HIV+ M scenario, all households adopted grain amaranth production for sale when an adult female contracted HIV (Table 7-15). Therefore, in general throughout the Amukura community, grain amaranth was more frequently adopted as a cash crop than as a food crop. All households increased their sales of grain amaranth except for households 3 and 6, which reduced grain amaranth sales during the asymptomatic phase (years 4-8) because they no longer had enough cash to invest in grain amaranth production for sale in that period. All other households increased grain amaranth production for sale for the same reasons as under the HIV+ M scenario – a household was under stress at a particular time and required a quick return on an investment and had enough available cash to invest in grain amaranth

production. Also similar to the HIV+ M scenario was the continuance of grain amaranth sales by multiple households through the asymptomatic phase. The reduction in available male labor even during this asymptomatic phase required households to restructure their priorities of cash generating activities, forcing households to switch to grain amaranth production for sale as a viable alternative for generating cash quickly.

Table 7-15. Total sales of grain amaranth (bags) for years 2-10 for Amukura households under the HIV+ F scenario

Household (composition in years 1-4)	Year									
	2	3	4	5	6	7	8	9	10	Total
1 (0-2-2-3-1)	3.84	4.28	1.58	0.58	0	0	0	0	0	10.29
2 (0-1-0-2-1)	0	3.51	1.48	0.46	0	0	0	0	0	5.46
3 (0-1-1-1-3)	1.15	2.98	0.37	0	0.33	0	0	0	0	4.83
5 (1-1-0-0-2)	5.69	5.88	2.91	2.16	0.61	1.35	0	4.04	7.15	29.79
6 (1-1-3-3-1)	6.71	4.54	1.80	0	0.51	0	1.78	4.43	5.69	25.47
7 (1-1-1-1-1)	1.65	2.78	0.30	0.44	0	3.45	0	4.88	5.23	18.73
8 (1-1-1-0-2)	10.65	10.27	6.84	6.90	6.59	6.18	1.72	4.99	6.88	61.00
9 (1-2-1-1-2)	0	1.54	0	0	0	0	0	3.03	0	4.57
10 (2-3-3-2-0)	0	0	0	0	0	1.65	1.67	7.98	0.77	12.07
11 (1-1-0-0-0)	0.25	4.65	0	4.34	2.70	2.88	1.68	1.10	1.49	19.08
12 (1-1-2-2-4)	7.72	14.83	6.92	8.40	5.59	8.04	7.14	5.38	7.09	71.10
13 (2-1-1-0-1)	14.41	13.67	9.77	7.59	2.59	3.51	0	0	0	51.55
14 (1-3-0-2-3)	0	0	0	0	0	0	0	0	0.04	0.04
15 (1-1-0-0-1)	2.45	3.15	0.07	0	0.75	0.05	4.21	3.68	5.01	19.38
16 (1-1-0-1-1)	0	1.46	0	0	0	0	0	1.87	0.24	3.57

The changes in the seasonal pattern of grain amaranth sales compared with the AMAR scenario was also similar between the two HIV+ scenarios. Under the HIV+ F scenario, all household grain amaranth sales increased in the intermediate season (May-July), as households squeezed in an additional crop to generate much-needed cash for investment in either food production for consumption or food purchasing (Table 7-16). During the other two seasons, all households reduced grain amaranth sales, except for a few households that increased production for sale during these seasons in

years 3 and 9 to help overcome stressful periods. These overall reductions in these two major seasons is representative of an overall decline in the sales of agricultural commodities due to the impacts of HIV on reducing household available labor and consequently available cash for investment.

Table 7-16. Comparison of seasonal sales of grain amaranth by Amukura households (total bags sold years 2-10) under the HIV+ F scenario with sales under the AMAR scenario

Household (composition in years 1-4)	Total under HIV+ F			Change in sales (HIV+ F minus AMAR scenario)		
	Feb-Apr	May-Jul	Aug-Oct	Feb-Apr	May-Jul	Aug-Oct
1 (0-2-2-3-1)	6.21	4.09	0	2.37	4.09	-0.75
2 (0-1-0-2-1)	5.14	0	0.32	5.12	0	0.32
3 (0-1-1-1-3)	3.43	0.41	0.99	-1.36	2.02	0.84
5 (1-1-0-0-2)	11.50	10.56	7.73	-1.40	7.44	3.76
6 (1-1-3-3-1)	12.70	9.31	3.45	-7.33	5.86	-7.28
7 (1-1-1-1-1)	6.76	6.88	5.09	0.29	4.36	1.84
8 (1-1-1-0-2)	29.01	27.07	4.92	-7.46	24.52	-10.25
9 (1-2-1-1-2)	3.49	1.08	0	3.49	1.08	0
10 (2-3-3-2-0)	4.70	7.36	0	2.16	7.36	-2.54
11 (1-1-0-0-0)	13.38	5.20	0.50	11.02	5.20	-1.85
12 (1-1-2-2-4)	33.49	27.66	9.95	3.27	27.66	-5.67
13 (2-1-1-0-1)	24.56	20.08	6.90	-4.73	12.10	-4.34
14 (1-3-0-2-3)	0	0.04	0	0	0.04	0
15 (1-1-0-0-1)	11.14	8.24	0	8.85	8.24	-2.29
16 (1-1-0-1-1)	3.03	0.54	0	1.96	0.54	-1.07

However, there are some important distinctions between the impacts of HIV upon grain amaranth production for sale under this scenario compared with the HIV+ M scenario. Under this scenario, eight households (5, 6, 9, 10, 11, 12, 13 and 15) sold more grain amaranth and four households (7, 8, 14 and 16) sold less grain amaranth than under the HIV+ M scenario (Tables 7-12 and 7-15). For those households that sold more grain amaranth under this scenario, the reduction in available female labor forced the household to switch available male labor towards an increased focus on food

production and also cash crops that could generate a quick return on investments. Grain amaranth sales increased for these households due both to increased grain amaranth production for consumption, with the resulting surplus sold, and to increased grain amaranth production with the primary purpose of selling the grain amaranth as a quick return on cash investment. On the other hand, of the households that sold less grain amaranth under this scenario compared with under the HIV+ M scenario, households either had plentiful available male labor (7 and 8) or plentiful additional available female labor (14 and 16), which enabled these households to maintain to a greater extent investments in other cash generating activities. However, it is important to note that even these four households increased their total amount of grain amaranth sold under this scenario when compared with the AMAR scenario.

Another interesting difference between the two HIV+ scenarios was in their annual pattern of grain amaranth sales. For households that sold the most grain amaranth over time, years 2-4 remained the most important. This was because these years coincided with the phase of initial HIV infection, which was the time of the most stress upon a household due to the unexpected shock of an immediate reduction in available adult female labor. This was similar to the findings of the HIV+ M scenario. However, six households (7, 9, 10, 14, 15 and 16) sold more grain amaranth in years 8-10 than in years 2-4, which represented a distinct difference from either the AMAR or HIV+ M scenarios. These households did not sell as much grain amaranth as other MHH, indicating that for households that only sell small quantities of grain amaranth, the period around the death of an adult female is more important for grain amaranth production for sale than any other period. In addition, under the HIV+ F scenario, ten

households continued to sell grain amaranth in year 10 compared to only one household under the HIV+ M scenario (Tables 7-12 and 7-15). Eight of the ten households that continued to sell grain amaranth under this scenario actually increased their sales compared with year 9 (Table 7-15). This indicates that a loss of adult female labor puts many households in a position to continue to produce grain amaranth for sale. The stress of losing the main contributor to household food production forces the majority of households into a new pattern of cash generating activities, of which grain amaranth is at the fore as grain amaranth is not constrained to a gender domain at harvest time and households are able to generate quick cash returns from its sale.

The difference between adoption of grain amaranth production for sale between FHH and MHH was also highlighted under the HIV+ F scenario. FHH (households 1, 2 and 3) did not adopt as much grain amaranth as most MHH under this scenario (Table 7-15). This was because once these FHH lost their adult female labor, these households were left with only youths and children in the household, who focused predominantly on food production to maintain food security rather than on cash generating activities. This issue is highlighted further by the difference in grain amaranth sales under this scenario between household 1 and households 2 and 3. Household 1 had two adult females providing it with additional available adult labor, and so was able to sell more grain amaranth than households 2 and 3.

Changes in sales of agricultural commodities of Amukura households under the HIV+ adult female scenario

Under the HIV+ F scenario, there was the same general pattern as the adult HIV+ M scenario of an overall shift towards increased grain amaranth sales by Amukura households (Table 7-17). This shift was the case for both MHH and FHH alike. An

increase in sales of grain amaranth went hand-in-hand with reductions in the sales of other grains, legumes and milk. Household 2 was the only household to increase sales of other grains, and this was through an increase in the sale of sorghum and finger millet and the most viable options for this FHH whose youths had to resort to low-intensive grain crops to provide both food and cash for remaining household members.

The majority of households had to reduce their stock of cattle in times of crisis as a means of obtaining cash quickly, which in turn fed into the reduction in milk sales. The only other agricultural commodity that was sold more under the HIV+ F scenario compared with the AMAR scenario was cassava as it required fewer inputs and so could be more easily produced when households were under the stress of HIV – this finding was also similar to the HIV+ M scenario.

The only major difference between the two HIV scenarios in terms of changes in market sales of agricultural commodities was in sugar cane sales. For the HIV+ M scenario, all households apart from two had reduced sugar cane sales. The two that increased sugar sales (households 9 and 10) were able to do so as they still had enough available cash and male labor. However, under the HIV+ F scenario, there were three households (1, 10 and 14) that increased sugar cane sales, while the other households all reduced sugar sales. The critical factor for these three exceptions was that households 1, 10 and 14 were the only households to have additional female adults. Thus, when one adult female contracted HIV in these households, there was still at least one more adult female to provide labor. This resulted in the male labor in the household to continue to focus on cash generating activities, of which an increase in sugar cane production provided the greatest cash returns over time.

Table 7-17. Change in household cash obtained from sales of various agricultural commodities between HIV+ F scenario and AMAR scenario

Household (composition in years 1-4)	Amaranth	Other grains	Legumes	Cassava	Sugar	Beer	Milk	Cow
1 (0-2-2-3-1)	19985	-98259	-54875	2725	114752	2625	-25070	1006
2 (0-1-0-2-1)	19041	5787	-69345	3848	-95513	47	-40911	-3392
3 (0-1-1-1-3)	-8889	-11748	-6609	2548	-19852	-5797	-60597	-3998
5 (1-1-0-0-2)	34303	-13605	-39749	353	-24721	0	-48716	-2836
6 (1-1-3-3-1)	-30625	-49367	-65948	3300	-7179	-2758	-20648	-3321
7 (1-1-1-1-1)	22717	-19291	-77901	3541	-65777	2350	-19842	-3606
8 (1-1-1-0-2)	23834	-17594	-71824	-41624	-485188	-4504	-24605	-3730
9 (1-2-1-1-2)	15994	-72947	-54822	925	-6809	-6705	-46541	-8604
10 (2-3-3-2-0)	24501	-79478	-62819	0	254754	-19386	-5580	-4113
11 (1-1-0-0-0)	50297	-21154	-97336	5388	-59350	-3469	-27288	745
12 (1-1-2-2-4)	88374	-37025	-153901	36556	-515914	-2432	-21134	-4001
13 (2-1-1-0-1)	10638	-5865	-93196	12254	-393586	0	-50265	-2240
14 (1-3-0-2-3)	143	-33598	-55062	2900	18284	-11378	-26915	1802
15 (1-1-0-0-1)	51834	-17668	-70312	231	-252773	-8476	-27319	-2506
16 (1-1-0-1-1)	4970	-46117	-83070	1425	-49087	-7553	-13968	1867

Mwatate

Impacts of Adult HIV Infection upon Household Food Security

Before analyzing the impacts of HIV infection of adult members upon the potential adoption of grain amaranth within Mwatate households, the overall impacts upon food security in diverse households are discussed. These impacts are assessed for each scenario in turn.

HIV+ adult male scenario

When an adult male household member contracted HIV, ten out of twelve households were unable to meet either minimum calorie requirements or a combination of calorie and protein requirements (Table 7-18). Only households 11 and 16 remained food secure under this scenario. Unlike Amukura, households in Mwatate struggled more in providing enough calories for household consumption than providing enough

protein. This was due to the different cropping activities available to households between the two communities. In Mwatate, more protein-rich crops were available for production than in Amukura. Thus, the main challenge for Mwatate households was the provision of sufficient calories for household members.

Table 7-18. Mwatate households' change in calorie/protein consumption by time period under the HIV+ M scenario compared with the AMAR scenario

Household (composition in years 1-4)	Percentage reduction from minimum requirements under HIV+ M scenario						Percentage reduction under HIV+ M scenario compared with AMAR scenario					
	Calories			Protein			Calories			Protein		
	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10
5 (1-1-0-0-2)	2	0	0	0	0	0	2	0	0	0	0	0
6 (1-1-3-3-1)	0	20	0	0	14	0	0	20	0	0	14	0
7 (1-1-1-1-1)	10	0	0	3	0	0	10	0	0	3	0	0
8 (1-1-2-0-2)	30	8	8	21	0	0	21	8	8	21	0	0
9 (1-2-1-1-2)	9	0	19	0	0	10	9	0	19	0	0	10
10 (2-2-2-2-1)	10	0	0	5	0	0	10	0	0	5	0	0
11 (1-1-0-0-0)	0	0	0	0	0	0	0	0	0	0	0	0
12 (1-1-2-2-3)	10	0	0	1	0	0	10	0	0	1	0	0
13 (2-1-1-0-2)	18	0	0	6	0	0	12	0	0	6	0	0
14 (1-3-1-2-4)	30	0	20	23	0	13	30	0	20	23	0	13
15 (1-1-1-0-1)	40	15	14	35	5	5	40	15	14	35	5	5
16 (1-1-0-1-1)	0	0	0	0	0	0	0	0	0	0	0	0

Households 11 and 16 were able to maintain household food security throughout all years due to a combination of low consumer-producer ratios and plentiful available cash and/or land resources to utilize to provide food for household consumption. Although the consumer-producer ratio of household 11 increased sharply following the death of the adult male (Table 7-19), this household had generated sufficient cash to purchase enough food in years 9 and 10 to maintain household food security. Household 16, meanwhile, maintained a low consumer-producer ratio throughout all years and also had plentiful available land and cash to help provide enough food for household consumption even in times of stress.

Table 7-19. Change over time of household consumer-producer ratios under the HIV+ M scenario

	Consumer-Producer ratio					
Household (composition in years 1-4)	Yr 2 Pre-HIV infection	Yr 3 Initial infection	Yr 4 Asymptomatic	Yrs 5-7 Asymptomatic	Yr 8 Asymptomatic	Yrs 9-10 Post-death
5 (1-1-0-0-2)	2.23	3.53	2.56	2.34	2.27	2.89
6 (1-1-3-3-1)	1.83	2.08	1.92	2.16	1.87	2.05
7 (1-1-1-1-1)	1.70	2.14	1.86	1.80	1.80	2.10
8 (1-1-2-0-2)	2.14	2.75	2.33	2.84	2.22	2.67
9 (1-2-1-1-2)	1.81	2.18	1.94	1.91	2.22	2.55
10 (2-2-2-2-1)	1.51	1.89	1.65	1.82	1.82	2.09
11 (1-1-0-0-0)	1.00	1.42	1.18	1.68	2.34	3.34
12 (1-1-2-2-3)	2.46	2.98	2.62	2.22	2.19	2.54
13 (2-1-1-0-2)	1.78	2.81	2.09	1.98	1.65	2.10
14 (1-3-1-2-4)	2.15	2.49	2.26	2.20	1.97	2.10
15 (1-1-1-0-1)	1.63	2.19	1.82	1.80	2.27	2.89
16 (1-1-0-1-1)	1.63	2.19	1.82	1.80	1.41	1.50

For those households that were unable to maintain food security, times of the greatest food insecurity coincided with times of high stress due to HIV – year 3 (initial phase of infection) and years 9 and 10 (death and the year following the death of an adult male). The only exception to this was household 6 which was most food insecure in years 5 through 7 due to the stress of the birth of an additional child into the household. The addition of this newborn combined with the asymptomatic phase of HIV for an adult male in the household was more of a strain on food security for this particular household than the severe impacts of HIV in years 3, 9 and 10.

Households 8, 9, 14 and 15 were the four households that were the most food insecure under this scenario (Table 7-18). However, out of all the households, households 5 and 12 were the two with consistently high consumer-producer ratios throughout all years, and yet these households were not the most food insecure in the community under this scenario (Table 7-19). Therefore, consumer-producer ratios were not the overriding factor determining the severity of HIV impacts on household food

security under the HIV+ M scenario. Instead, diverse and complex interactions of factors were important in reducing household food security in the most food insecure households – household 8 lacked enough available female labor to produce for consumption; household 9 was most food insecure in years 9 and 10 due not only to HIV but also due to the birth of another child; household 14 struggled to produce enough food for consumption due simply to its large and continually increasing household size (11 members in year 2, reaching 13 members by year 8); household 15 struggled to maintain food security due to lack of available land (only 2.5 acres). Therefore, the impacts of HIV infection of an adult male upon household food security in Mwatate are household-specific and dependent upon the complex interaction of a range of available household resources.

HIV+ adult female scenario

Similar to Amukura, the impacts upon household food security in Mwatate were in general more severe under the HIV+ F scenario than the HIV+ M scenario. All households failed to meet consumption requirements under the HIV+ F scenario except for household 16 (Table 7-20), which had plentiful available cash and land as well as a consistently low consumer-producer ratio even during times of stress due to HIV (Table 7-21). This household was able to maintain food security under both HIV scenarios, so was the household most resistant to the shock of HIV adult infection.

Similar to the HIV+ M scenario, the impacts of HIV upon household food security were more severe during the initial phase of infection (year 3) and the years of and following the death of an adult female (years 9 and 10). The only exception to this was household 9 which was most food insecure under this scenario in years 5 through 7 as it was continuing to struggle in these years to reprioritize production activities following

the shock of the initial infection in year 3. The majority of households were more food insecure in years 3 and 4 than in years 9 and 10 as the initial phase of infection came as a shock to these households, whereas the death of an adult female in year 9 could be expected and thus planned for to some extent.

Table 7-20. Mwatate households' change in calorie/protein consumption by time period under the HIV+ F scenario compared with the AMAR scenario

Household (composition in years 1-4)	Percentage reduction from minimum requirements under HIV+ F scenario						Percentage reduction under HIV+ F scenario compared with AMAR scenario					
	Calories			Protein			Calories			Protein		
	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10	Year 2-4	Year 5-7	Year 8-10
1 (0-2-2-3-1)	10	0	0	7	0	0	10	0	0	7	0	0
2 (0-1-1-1-1)	60	0	0	53	0	0	60	0	0	53	0	0
3 (0-1-1-2-2)	50	8	18	45	0	15	50	8	18	45	0	15
4 (0-1-1-0-1)	59	2	6	54	0	3	59	2	6	54	0	3
5 (1-1-0-0-2)	43	9	47	30	0	31	43	9	47	30	0	31
6 (1-1-3-3-1)	10	10	0	5	3	0	10	10	0	5	3	0
7 (1-1-1-1-1)	60	12	0	57	5	0	60	12	0	57	5	0
8 (1-1-2-0-2)	50	6	30	42	0	5	41	6	30	42	0	5
9 (1-2-1-1-2)	10	17	0	1	9	0	10	17	0	1	9	0
10 (2-2-2-2-1)	10	0	0	5	0	0	10	0	0	5	0	0
11 (1-1-0-0-0)	0	0	36	0	0	12	0	0	36	0	0	12
12 (1-1-2-2-3)	30	0	10	20	0	0	30	0	10	20	0	0
13 (2-1-1-0-2)	60	0	0	50	0	0	54	0	0	50	0	0
14 (1-3-1-2-4)	30	0	10	23	0	3	30	0	10	23	0	3
15 (1-1-1-0-1)	60	0	47	53	0	30	60	0	47	53	0	30
16 (1-1-0-1-1)	0	0	0	0	0	0	0	0	0	0	0	0

In years 3 and 4, the three FHH that had only one adult female (households 2, 3 and 4; not household 1) had to reduce their calorie intake by over 50%, thus indicating that these households were extremely food insecure as a result of their adult female contracting HIV (Table 7-20). Under the assumption that these households were able to survive this period of extreme food insecurity, however, they were able to reprioritize household food production for consumption strategies in following years so that household food security was not significantly reduced following the death of the adult female in year 9 (Table 7-20).

Seven MHH (households 5, 7, 8, 12, 13, 14 and 15) were also significantly food insecure in years 3 and 4, to either the same degree or more severe than under the HIV+ M scenario (Tables 7-18 and 7-20). The severity of this food insecurity was brought about by a range of interacting factors that were either directly due to the HIV infection of an adult female or were inherent in the household even under the AMAR scenario. The most important reasons for severe food insecurity in a household in years 3 and 4 were consistently high consumer-producer ratios (households 5, 8, 12 and 14), low availability of land (households 5, 7 and 15) and pre-existing food insecurity under the AMAR scenario (households 8 and 13).

Table 7-21. Change over time of household consumer-producer ratios under the HIV+ F scenario

	Consumer-Producer ratio					
Household (composition in years 1-4)	Yr 2 Pre-HIV infection	Yr 3 Initial infection	Yr 4 Asymptomatic	Yrs 5-7 Asymptomatic	Yr 8 Asymptomatic	Yrs 9-10 Post-death
1 (0-2-2-3-1)	1.80	2.24	2.02	1.94	1.58	1.60
2 (0-1-1-1-1)	2.10	2.72	2.38	2.41	1.63	2.00
3 (0-1-1-2-2)	2.67	3.35	2.94	3.17	1.76	2.00
4 (0-1-1-0-1)	2.14	3.08	2.54	2.41	1.63	2.00
5 (1-1-0-0-2)	2.23	2.99	2.56	2.34	2.27	2.89
6 (1-1-3-3-1)	1.83	2.01	1.92	2.16	1.87	2.05
7 (1-1-1-1-1)	1.70	2.00	1.86	1.80	1.80	2.10
8 (1-1-2-0-2)	2.14	2.53	2.33	2.84	2.22	2.67
9 (1-2-1-1-2)	1.81	2.35	2.07	1.98	2.31	2.55
10 (2-2-2-2-1)	1.51	1.77	1.65	1.82	1.82	1.87
11 (1-1-0-0-0)	1.00	1.27	1.18	1.68	2.34	3.34
12 (1-1-2-2-3)	2.46	2.82	2.62	2.22	2.19	2.54
13 (2-1-1-0-2)	1.78	2.05	1.93	1.89	1.58	1.70
14 (1-3-1-2-4)	2.15	2.91	2.48	2.34	2.07	2.10
15 (1-1-1-0-1)	1.63	1.98	1.82	1.80	2.27	2.89
16 (1-1-0-1-1)	1.63	2.00	1.82	1.80	1.41	1.50

However, unlike the HIV adult male scenario, consistently highest consumer-producer ratios were the most important determining factor under the HIV+ F scenario for severe household food insecurity following the death of an adult female in year 9.

Households 5, 8, 11 and 15 had the highest consumer-producer ratios in years 9 and 10 and at the same time were the most food insecure (Tables 7-20 and 7-21). Therefore, under this scenario, consumer-producer ratios provided a clear indication of which households would continue to struggle to meet consumption requirements following the death of an adult female.

Impacts of Adult HIV Infection upon Household End Cash

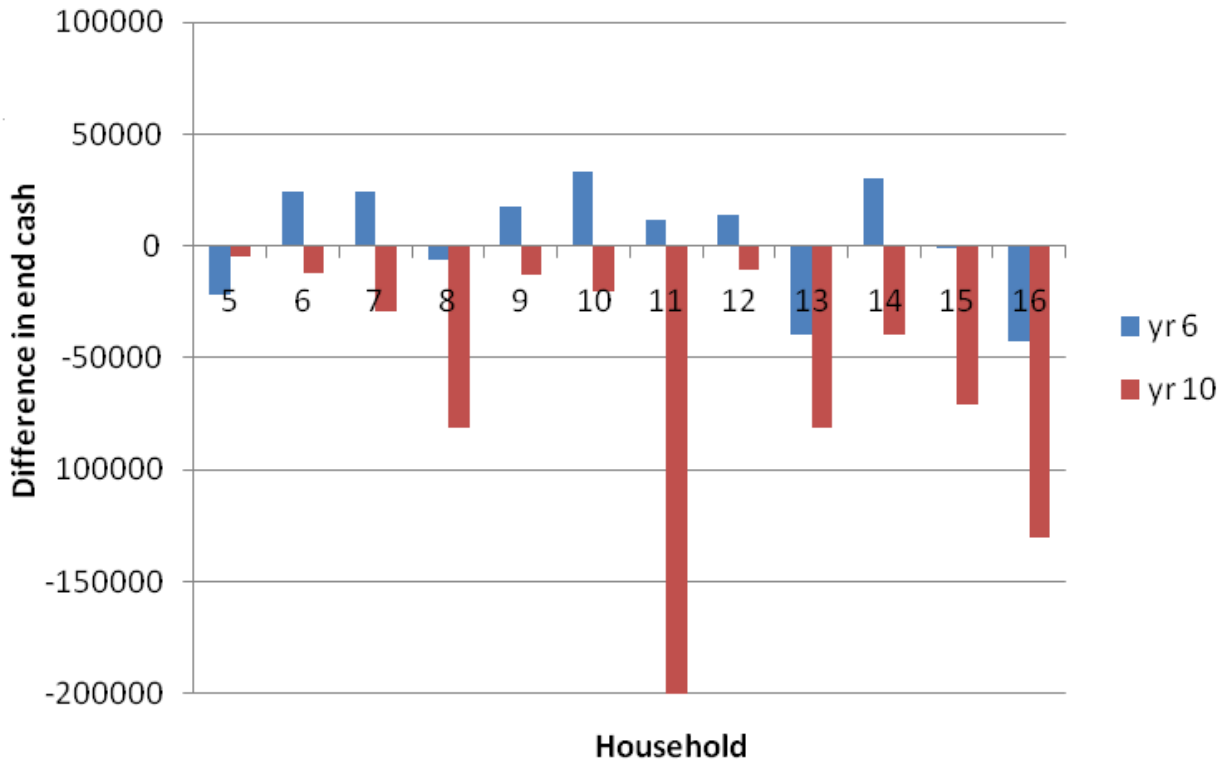

Figure 7-5. Difference in household end cash in year 6 and year 10 between AMAR scenario and HIV+ M scenario

Although the majority of Mwatate households under both HIV+ scenarios had increased end cash in year 6 compared with the AMAR scenario, all households under both HIV+ scenarios had reduced end cash in year 10 compared with the AMAR scenario (Figures 7-5 and 7-6). The increases in end cash in year 6 were due to

households reprioritizing activities in the context of an adult member living with HIV. Most households increased end cash in year 6 by removing youths from school (Table 7-22), and thus saving on school fees, or by increasing investments in cash generating activities during the asymptomatic phase of infection (beginning in year 4). This additional cash was required by households by years 9 and 10 for purchasing food and/or hiring additional labor.

The reductions in end cash in year 10 among Mwatate households were due to a general shift away from cash generating activities and towards food production activities as households attempted to maintain food security under the stress of HIV. HIV infection of an adult member brought end cash quantities in year 10 to minimal levels among all Mwatate households under both HIV+ scenarios. Thus, the households that had the highest reductions in end cash in year 10 (households 11 and 16) were those that had generated the most end cash in year 10 under the AMAR scenario. These two households not only had the most end cash to lose, but were also two of the households with the lowest supply of adult labor. Therefore, due to HIV infection of an adult member, these households removed adult male labor from cash generating activities either because the adult male was sick (HIV+ adult male scenario) or because the adult male was needed for food production activities because the adult female was sick (HIV+ adult female scenario).

Figure 7-6. Difference in household end cash in year 6 and year 10 between AMAR scenario and HIV+ F scenario

Similar to Amukura, there was little difference in each household's reduction in end cash in year 10 between the HIV+ M and HIV+ F scenarios. The biggest difference in reductions in end cash in year 10 between the HIV+ scenarios was in households 5 and 13. These two households had greater reductions in end cash in year 10 under the HIV+ F scenario. This was because under the HIV+ F scenario, the reduction in available adult female labor led to available male labor being switched to food production, whereas under the HIV+ M scenario, these households still had enough available male labor to maintain a higher level of investment in cash generating activities.

Under the HIV+ F scenario, the reductions in end cash in year 10 for FHH were small for households 2, 3 and 4, which only had one adult female. This was because these households were not invested in many cash generating activities under the AMAR

scenario. However, household 1, which had two adult females, experienced a much more pronounced reduction in end cash in year 10 as the remaining healthy adult female had to focus primarily on food production for the household and no longer on cash generating activities.

Table 7-22. Number of years of youths' schooling lost due to HIV infection of an adult household member in Mwatate households between years 2 and 10.

Household (composition in years 1-4)	HIV+ M scenario	HIV+ F scenario
1 (0-2-2-3-1)	-	2
2 (0-1-1-1-1)	-	2
3 (0-1-1-2-2)	-	1
4 (0-1-1-0-1)	-	2
5 (1-1-0-0-2)	2	3
6 (1-1-3-3-1)	0	0
7 (1-1-1-1-1)	2	1
8 (1-1-2-0-2)	0	3
9 (1-2-1-1-2)	1	0
10 (2-2-2-2-1)	2	3
11 (1-1-0-0-0)	0	0
12 (1-1-2-2-3)	2	2
13 (2-1-1-0-2)	0	2
14 (1-3-1-2-4)	10	10
15 (1-1-1-0-1)	3	5
16 (1-1-0-1-1)	1	0

Changes in end cash were linked to changes in the number of youths kept in school by households. In general, more households in Mwatate had to remove youths from school under both HIV+ scenarios than households in Amukura. Households in Mwatate had invested less in grain amaranth under the AMAR scenario than households in Amukura. As grain amaranth was the crop that could provide the quickest cash returns, Mwatate households were left with fewer options than Amukura households for generating cash quickly. Therefore, more Mwatate households turned to removing youths from school during times of acute stress. Eight out of twelve households under the HIV+ M scenario and twelve out of sixteen households under the

HIV+ F scenario temporarily removed youths from school in Mwatate (Table 7-22). During the asymptomatic phase, most households were able to keep their youths to school due to only minimal reductions in available adult labor, and hence minimal reductions in available cash. However, youths were often temporarily removed from school either in years 3 and 4 or in years 9 and 10 – at times of increased stress due to HIV.

Similar to Amukura, all FHH had to remove youths from school under the HIV+ F scenario (Table 7-22). These households turned to youths at times of acute stress to provide necessary labor for agricultural activities to meet household consumption needs, and so youths were removed from school. This also reduced cash expenses at this time of stress. For the twelve MHH, there was little difference between the two HIV scenarios – similar numbers of youths were removed under each scenario for each household. Household 14 removed the most youths from school, losing ten schooling years under each scenario (Table 7-22). This was due to the high number of people in the household, especially the high number of young children, for whom youth labor was needed in times of acute stress to provide for consumption needs.

Impacts of Adult HIV Infection upon the Potential Adoption of Grain Amaranth Production for Consumption

HIV+ adult male scenario

Overall, grain amaranth production for consumption was adopted by households in Mwatate to a lesser extent under the HIV+ M scenario compared with the AMAR scenario. Although the same number of households (two – households 8 and 13) adopted grain amaranth production for consumption under the HIV+ M scenario as under the AMAR scenario, the overall production of grain amaranth for consumption

was reduced for these households under the HIV+ M scenario. This was similar to the situation for households under the HIV+ M scenario in Amukura.

Mwatate households 8 and 13 lacked female youth labor to support food production activities and were under the most stress in the AMAR scenario as these were the only households failing to meet necessary minimum consumption requirements. The additional stress of HIV infection of an adult male resulted in further reductions in production for consumption of almost one bag per household in this scenario compared with the AMAR scenario. The production of grain amaranth for consumption under the AMAR scenario was low, and therefore was reduced to minimal levels following year 3 (Table 7-23).

Table 7-23. Total consumption of grain amaranth (bags) for years 2-10 for Mwatate households under the HIV+ M scenario

Household (composition in years 1-4)	Year 2	3	4	5	6	7	8	9	10	Total
8 (1-1-2-0-2)	0.80	0.53	0	0.07	0	0.91	0	0	0	2.31
13 (2-1-1-0-2)	2.46	0.33	0	0	0	0	0	0	0	2.79

In terms of annual variation of grain amaranth production for consumption, the production of grain amaranth for consumption by households 8 and 13 was similar in year 3 to that under the AMAR scenario. In this year, grain amaranth production for consumption is maintained by these households due to the stress of reduced available adult male labor in the initial phase of HIV infection. However, during the asymptomatic phase, both households reduced their production of grain amaranth for consumption as HIV infection of an adult male resulted in lower available cash during these years. Therefore, during the asymptomatic phase, these households turned increasingly to other food production activities that required less cash investment than grain amaranth.

In addition, the death of an adult male in year 9 did not trigger grain amaranth production for consumption by households 8 and 13 as they still had sufficient available female labor to continue the same food production activities as under the AMAR scenario.

Table 7-24. Seasonal production of grain amaranth for consumption under HIV+ M scenario compared with AMAR scenario (total bags consumed years 2-10)

Household (composition in years 1-4)	Total production (HIV+ M)		Change in production (HIV+ M minus AMAR)	
	Feb-Apr	Aug-Oct	Feb-Apr	Aug-Oct
8 (1-1-2-0-2)	2.20	0.11	-0.62	-0.22
13 (2-1-1-0-2)	1.78	1.01	-0.40	-0.36

In terms of variations in seasonal production of grain amaranth for consumption, households 8 and 13 reduced production in both seasons by similar quantities. Therefore, the same pattern of seasonal grain amaranth production for consumption as under the AMAR scenario remained with more grain amaranth produced for consumption in the February to April (first) season than in the August to October (second) season (Table 7-24). This was primarily because the first season was not as busy as the second season for Mwatate households, so households had more labor available in the first season to produce grain amaranth.

The stress of HIV infection of an adult male also did not lead any of the remaining fourteen Mwatate households to adopt grain amaranth production for consumption. This was due to three main reasons. First, households in Mwatate had access to a wider range of legumes for production. As the primary contribution towards household consumption requirements of grain amaranth is its high protein content, the availability of a number of high protein legumes for production instead of grain amaranth hindered the adoption of grain amaranth for consumption even in times of stress due to HIV.

Secondly, many households were unable to adopt grain amaranth production for consumption in year 3 due to lack of available cash. Grain amaranth required more initial cash to be invested than most other crops due to the high price of its seed. Thirdly, in years 9 and 10 – the other time of acute stress under this scenario – households had typically planned their resource availability so that they had enough resources to invest in food cropping activities, such as increases in cultivated areas of legumes, which provided higher production returns than grain amaranth.

Changes in diets of Mwatate households under the HIV+ adult male scenario

The contraction of HIV by an adult male household member brought about widespread impacts not only upon the potential adoption of grain amaranth for consumption but also upon the overall consumption strategies adopted by households. An assessment of the overall picture of consumption for these households uncovers the broader picture behind why so few households adopted grain amaranth production for consumption even under the stress of an adult male contracting HIV.

Under this HIV+ M scenario, the major change in household consumption patterns is a reduction in maize consumed by all households (Table 7-25). All households except household 12 reduced their intake of cassava, while the majority of households also reduced their intake of vegetables. Ugali, made from maize and/or cassava, and vegetables are two of the three core ingredients in traditional Mwatate meals. Households consumed less of these foods due to reductions in available adult male labor, with the result that ten of the twelve MHH were unable to meet minimum necessary consumption requirements.

Table 7-25. Change in total consumption of various foods (bags) between HIV+ M scenario and AMAR scenario for years 3-10 for Mwatate households

Household (composition in years 1-4)	Maize	Sorghum	Amaranth	Beans	Ground nut	Pig. Pea	Cassava	Veg.
5 (1-1-0-0-2)	0.47	0	0	-3.55	0.18	3.16	-0.51	-1.65
6 (1-1-3-3-1)	-22.42	0	0	-1.94	0.30	0.49	-2.17	-1.88
7 (1-1-1-1-1)	-3.88	0	0	-1.65	0.44	0.97	-0.52	-1.65
8 (1-1-2-0-2)	-14.80	0	-0.84	-1.94	2.13	-0.70	-1.26	-1.28
9 (1-2-1-1-2)	-16.41	0	0	-2.66	0.46	1.39	-1.87	-1.27
10 (2-2-2-2-1)	-9.40	0	0	-1.10	0.58	0.05	-0.49	-1.88
11 (1-1-0-0-0)	-16.70	8.77	0	-0.57	0.12	0.85	-3.33	-1.28
12 (1-1-2-2-3)	-5.79	0	0	-1.90	0.04	1.52	0.62	-1.88
13 (2-1-1-0-2)	1.74	0	-0.76	-0.02	0	-0.24	-0.85	0
14 (1-3-1-2-4)	-32.24	0	0	2.08	-3.93	0	-2.81	0.02
15 (1-1-1-0-1)	-23.78	0	0	-1.24	0	-0.37	-3.39	0.04
16 (1-1-0-1-1)	-7.89	5.88	0	-0.66	0.64	-0.05	-0.29	-0.38

Meanwhile, households looked to offset the reductions in maize, cassava and vegetable consumption with increases in legume intake under this scenario, as legumes had the potential to provide high calories and protein. Out of all legumes, household consumption of pigeon pea increased the most because pigeon peas required less labor than other legumes as they only had to be replanted once every two years. Groundnut consumption increased in all but three households, yet not to the same degree as pigeon peas due to both the high relative cost of groundnut seed (90Kshs/kg versus 60Kshs/kg for pigeon pea) and the high labor requirement of shelling groundnuts by hand compared to shelling pigeon peas by threshing. Grain amaranth production for consumption was not as favorable for most households in comparison to increasing legume production for consumption, primarily due to household compositions being heavily dependent upon adult female labor under this scenario. Adult female labor was relatively much more available than adult male labor for all households, and as legumes were in the female domain and required female labor for post-harvest processing,

households chose to increase legume production over grain amaranth consumption. The only decline in legume consumption was for beans as these were typically intercropped with maize, therefore linking maize and bean production for consumption. Household 14 was the only household to increase intake of beans, replacing groundnut as this household had the labor to produce legumes but neither the cash available to afford expensive groundnut seed nor the land available to increase acreage devoted to perennial pigeon pea production.

For households 11 and 16, which had the largest reductions in available cash, sorghum consumption was increased. Sorghum seed was cheaper than maize seed in Mwatate and sorghum also had a higher protein content than maize, so was an increasingly preferred livelihood strategy option for households under high stress - with low available cash and needing to provide high calorie, high protein foods for their households. Although under acute stress, households 11 and 16 adopted sorghum production for consumption over grain amaranth. It is likely that if all households were put under similar cash stress to these households, sorghum would increasingly be the grain crop of choice over grain amaranth or maize. This was due in part to the availability of relatively inexpensive sorghum seed in Mwatate. It was also due to sorghum being a crop in the female domain and households having compositions depending heavily on adult female labor due to adult male HIV+ infection under this scenario.

HIV+ adult female scenario

Overall, grain amaranth production for consumption was adopted by households in Mwatate to a greater extent under the HIV+ F scenario compared with the AMAR scenario – the opposite of the shift witnessed under the HIV+ M scenario. Not only did

more households (eight in addition to households 8 and 13) adopt grain amaranth production for consumption under this scenario than under both the AMAR and HIV+ M scenario, but also more grain amaranth was produced for consumption by households 8 and 13. Seasonal patterns of grain amaranth production for consumption were consistent with other Mwatate scenarios, with higher production in the February to April (first) season than in the August to October (second) season for all households due to the greater availability of labor in the first season (Figure 7-7).

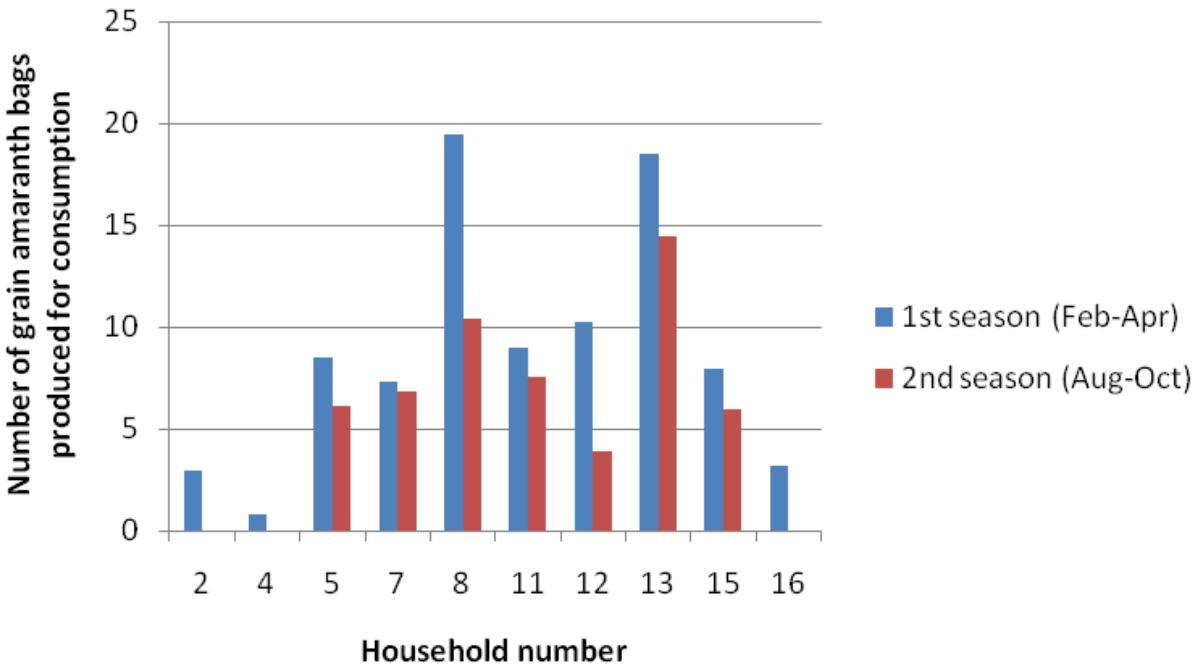

Figure 7-7. Total number of grain amaranth bags produced for consumption by season between years 2 and 10 for Mwatate households under the HIV+ F scenario

However, Mwatate households did not adopt as much grain amaranth production for consumption as Amukura households under this HIV+ F scenario. The main difference between Mwatate household and Amukura household grain amaranth production for consumption under this scenario was the lack of production during the asymptomatic phase by Mwatate households (Table 7-26). This was because during the

asymptomatic phase foods other than grain amaranth were cheaper to produce and households had more available labor at this time to produce a wide variety of foods. Thus, unlike Amukura, Mwatate households that produced grain amaranth for consumption under this scenario provided a distinct pattern of production only in years of severe stress – year 3, and years 9 and 10.

Table 7-26. Total consumption of grain amaranth (bags) for years 2-10 for Mwatate households under the HIV+ F scenario

Household (composition in years 1-4)	Year									
	2	3	4	5	6	7	8	9	10	Total
2 (0-1-1-1-1)	0	2.94	0	0	0	0	0	0	0	2.94
4 (0-1-1-0-1)	0	0.78	0	0	0	0	0	0	0	0.78
5 (1-1-0-0-2)	0	2.71	0	0	0	0	0	5.33	6.54	14.59
7 (1-1-1-1-1)	0	0	0	0	0	0	0	6.89	7.26	14.15
8 (1-1-2-0-2)	0.80	4.79	0	0.79	0.66	2.49	0	9.71	10.67	29.91
11 (1-1-0-0-0)	0	1.46	0	0	0	0	0	8.05	7.08	16.59
12 (1-1-2-2-3)	0	5.61	0	0	0	0	0	4.20	4.27	14.08
13 (2-1-1-0-2)	2.46	4.64	0	0	0	0	0	12.26	13.60	32.96
15 (1-1-1-0-1)	0	2.35	0	0	0	0	0	4.31	7.29	13.95
16 (1-1-0-1-1)	0	2.83	0	0	0	0	0	0.35	0	3.18

Nine out of ten households produced grain amaranth for consumption in year 3, with households 8, 12 and 13 producing the most in this year (Table 7-26). Households 8 and 13 were already producing grain amaranth for consumption under the AMAR scenario. Household 12 had one of the most consistently high consumer-producer ratios in years 2, 3 and 4, which put additional stress on this household around the time of initial infection, thus resulting in higher production of grain amaranth for consumption for this household than other households. Household 7 was the only household to not produce grain amaranth for consumption in year 3 as this was the only household with a balanced household composition (1-1-1-1-1) at this time.

Out of these ten households, all MHH (5, 7, 8, 11, 12, 13, 15 and 16) produced more grain amaranth for consumption in years 9 and 10 than in year 3 as the loss of an adult female to the household was more stressful to MHH than the reduction of adult female labor due to initial infection in year 3, even though households had time to plan for the death of an adult female. The permanent loss of available adult female labor in year 9 forced these MHH to choose alternative strategies which included grain amaranth production for providing necessary calories and protein to their households. On the other hand, the two FHH that produced grain amaranth for consumption in year 3 (households 2 and 4) did not produce grain amaranth for consumption in years 9 and 10. Following the death of their only adult member in year 9, households 2 and 4 maintained their current food production strategies as they had neither the available cash nor labor to invest in grain amaranth production.

Overall, there were both push and pull reasons as to why some households adopted and others did not adopt grain amaranth production for consumption under the HIV+ F scenario. All households that did not produce grain amaranth for consumption (1, 3, 6, 9, 10 and 14) had at least two additional female members (adults and/or youth) which significantly lessened the blow of a reduction in available household female labor due to HIV. Therefore, these households did not adopt grain amaranth production for consumption as they were able to maintain their cropping practices for food production as under the AMAR scenario, albeit at a reduced level of production. The reduction in available female labor in these households was not sufficient for these households to justify the costs of switching investments from current cropping activities towards grain amaranth production for consumption.

For the other ten households, there were several interacting reasons that enticed these households into producing grain amaranth for consumption. Households 8 and 13 were already under the most stress under the AMAR scenario, and so the additional stress of HIV infection of an adult female resulted in these households adopting yet more grain amaranth production for consumption. Households 5, 7, 11, 12 and 15 were the other households that each produced more than 10 bags of grain amaranth for consumption. Apart from household 12, these households were all land constrained, having acreages smaller than the Mwatate average. The reduction in available adult female labor in this scenario forced these households to consider grain amaranth as a viable cropping strategy partly because grain amaranth did not require land for long periods of time in comparison with many other crops in order to produce a harvestable yield. Furthermore, households 5, 11, 12 and 15 (i.e. excluding household 7) had high consumer-producer ratios during the years that they produced grain amaranth for consumption. Household composition stress therefore led these households to adopt grain amaranth production for consumption because grain amaranth did not require any female-specific labor, was quick to harvest, and was protein and calorie rich.

The importance of continuing grain amaranth production for consumption by half of the Mwatate households (eight out of sixteen) in year 10 underlines the lasting impact of the death of an adult female household member. For these households, livelihood strategies had been permanently shifted to a new mode of production, in which grain amaranth played an important role. This highlights that grain amaranth production for consumption is not only important for certain households under this scenario during periods of acute stress, but also during periods of chronic stress.

Changes in diets of Mwatate households under the HIV+ adult female scenario

The changes in diets of Mwatate households under this scenario reveals a more complete picture of the shift to grain amaranth production for consumption by some households and not by others. All households reduced their consumption of maize and beans under this scenario, except for household 14, which switched to beans from groundnut consumption because of its large household size (Table 7-27). Reductions in maize consumption were generally greater for households that adopted grain amaranth consumption. Grain amaranth was higher in protein and calories than maize and so was consumed by households under stress and struggling to meet minimum necessary consumption requirements.

The stress on available female labor under this scenario resulted in large increases in cassava consumption by all four FHH (Table 7-27). These households did not have enough available labor to produce other female domain crops such as sorghum, so cassava consumption was increased to help make up calories lost from a reduction in maize consumption. Households 6 and 14 were the only two MHH with a significant increase in cassava consumption. These were both large households with many mouths to feed, and with cassava being a low input crop in terms of cash and labor, cassava was one of the crops chosen by these households to help meet minimum consumption requirements. Households that increased cassava consumption typically did not produce grain amaranth for consumption. This is because cassava production demands high acreages, and so increases in cassava production resulted in reduced available land area for other crops such as grain amaranth.

Table 7-27. Change in total consumption of various foods (bags) between HIV+ F scenario and AMAR scenario for years 3-10 for Mwatate households

Household (composition in years 1-4)	Maize	Amaranth	Beans	Groundnut	Pigeon Pea	Cassava	Vegetables
1 (0-2-2-3-1)	-1.63	0	-0.04	0.10	0.02	22.15	0
2 (0-1-1-1-1)	-12.35	2.94	-0.17	0.10	-0.65	9.39	1.74
3 (0-1-1-2-2)	-27.17	0	-1.20	0.23	-0.47	13.62	0.67
4 (0-1-1-0-1)	-21.81	0.78	-2.83	0.16	1.76	7.81	0
5 (1-1-0-0-2)	-49.52	14.59	-4.37	0.10	1.37	-6.14	1.77
6 (1-1-3-3-1)	-15.51	0	-1.39	-0.10	0.70	0.86	1.88
7 (1-1-1-1-1)	-42.78	14.16	-2.82	0	0.51	-6.70	1.74
8 (1-1-2-0-2)	-55.89	26.77	-1.91	1.82	-2.68	-3.93	1.34
9 (1-2-1-1-2)	-22.35	0	-3.00	0.40	1.38	-0.85	1.43
10 (2-2-2-2-1)	-3.62	0	-3.39	0.36	2.49	-4.58	1.93
11 (1-1-0-0-0)	-27.87	16.59	-0.47	-0.17	-0.77	0.01	0.68
12 (1-1-2-2-3)	-31.88	14.09	-2.01	-0.90	1.25	-6.64	2.02
13 (2-1-1-0-2)	-38.56	29.45	-0.46	0.28	-2.25	-3.20	0
14 (1-3-1-2-4)	-19.48	0	3.69	-4.98	0	1.57	-0.20
15 (1-1-1-0-1)	-40.17	13.94	-1.74	0	-0.71	-4.22	-0.18
16 (1-1-0-1-1)	-3.45	3.18	-0.39	0.41	0.03	-0.18	0.23

Other crops consumed either did not significantly affect the adoption of grain amaranth consumption or were affected by changes in grain amaranth consumption. The majority of households slightly increased their intake of vegetables as they attempted to maintain balanced diets even under the stress of HIV in this scenario. There were also changes in groundnut and pigeon pea consumption which varied by household. Households with more available resources of cash, labor and land were more able to switch primary legume consumption from beans (which were typically intercropped with maize) towards groundnut, pigeon peas, or both than households with fewer available resources. For example, some households such as 11 and 15 lacked enough available female labor to increase consumption of any legumes, while other households such as 1, 4, 5, 9, 10 and 16 had enough available resources (especially

during the asymptomatic phase) to increase their consumption of both groundnut and pigeon peas (Table 7-27).

Impacts of Adult HIV Infection upon the Potential Adoption of Grain Amaranth Production for Sale

HIV+ adult male scenario

Eight households adopted grain amaranth production for sale compared with only two households that adopted grain amaranth production for consumption, implying that grain amaranth was more attractive as a cash crop than a food crop under the HIV+ M scenario for Mwatate households (Table 7-28). This was the same finding as for Amukura households – when an adult male contracts HIV, households are more likely to produce grain amaranth for sale than for food. However, unlike Amukura, not all Mwatate households adopted grain amaranth production for sale under this scenario. The number of households that sold grain amaranth under this HIV+ M scenario was the same as the number under the AMAR scenario. Households 5, 8, 11, 12, 13, 15 and 16 all continued to sell grain amaranth, and although household 6 no longer sold grain amaranth, household 7 began to sell grain amaranth under the HIV+ adult male scenario.

However, despite the same overall number of households producing grain amaranth for sale in both the AMAR and HIV+ M scenarios, all households reduced their grain amaranth sales under the HIV+ M scenario except for households 5 and 7. Household 7 increased the sale of grain amaranth during year 3 (initial phase of HIV infection) as a useful strategy to generate additional income quickly. Meanwhile, household 5 increased grain amaranth sales during years 4 and 8 – directly after the initial phase and directly before the death of an adult male. This household used its only

available male labor during the asymptomatic phase to boost cash at critical times to help the household get over and through times of acute stress. Both of these households had small land holdings which forced these households to choose to increase grain amaranth production for sale as a strategy that would enable them to better deal with times of stress.

Table 7-28. Total sales of grain amaranth (bags) for years 2-10 for Mwatate households under the HIV+ M scenario

	Year									
Household (composition in years 1-4)	2	3	4	5	6	7	8	9	10	Total
5 (1-1-0-0-2)	3.78	0.68	4.14	0	0	0	0.83	0.13	0	9.55
7 (1-1-1-1-1)	0	1.10	0	0	0	0	0	0	0	1.10
8 (1-1-2-0-2)	15.13	9.91	15.10	2.75	8.42	0.94	6.49	0	0	58.74
11 (1-1-0-0-0)	0	0	0	0	1.14	0	0	0	0	1.14
12 (1-1-2-2-3)	7.25	0	4.28	0	0	0	2.00	0	0	13.53
13 (2-1-1-0-2)	12.55	13.65	14.18	5.41	9.94	2.58	3.77	0.37	3.11	65.57
15 (1-1-1-0-1)	1.60	0	0	0	0	0	0	0	0	1.60
16 (1-1-0-1-1)	0.92	0	1.52	0	2.12	0	0.23	0	0	4.80

The other seven households (6, 8, 11, 12, 13, 15 and 16) reduced grain amaranth sales primarily because they no longer had sufficient available cash or labor to invest in grain amaranth as much as they had under the AMAR scenario. The reduction in available adult male labor due to HIV especially impacted households' abilities to generate cash as male labor was predominantly invested in cash generating activities. Reductions in available labor and cash therefore went hand in hand and both contributed to these households' reduced production of grain amaranth for sale under this scenario. The largest reductions in grain amaranth sales for these households therefore coincided with the times of greatest stress, especially years 3 and 9. Meanwhile, households were able to maintain levels of grain amaranth sales during the

asymptomatic phase of infection as the stress upon labor and cash resources during these years (4 through 8) was not as significant (Table 7-28).

Despite reductions in sales, households 8 and 13 continued to sell the most grain amaranth. These were the only ones to fail to meet minimum consumption requirements under the AMAR scenario. Under both the AMAR scenario and the HIV+ M scenario, these households were also the ones to produce the most grain amaranth for consumption. The high volume of grain amaranth sales of these households was therefore linked to the high levels of grain amaranth consumption by these same households, as they sold the surplus of what they did not consume.

Table 7-29. Comparison of seasonal sales of grain amaranth by Mwatate households (total bags sold years 2-10) under the HIV+ M scenario with sales under the AMAR scenario

Household (composition in years 1-4)	Total under HIV+ M		Change in sales (HIV+ M minus AMAR scenario)	
	Feb-Apr	Aug-Oct	Feb-Apr	Aug-Oct
5 (1-1-0-0-2)	2.50	7.05	0.52	0.59
6 (1-1-3-3-1)	0	0	0	-3.05
7 (1-1-1-1-1)	1.10	0	1.10	0
8 (1-1-2-0-2)	27.31	31.43	-10.84	-13.42
11 (1-1-0-0-0)	0	1.14	0	-4.81
12 (1-1-2-2-3)	2.17	11.36	0	-1.62
13 (2-1-1-0-2)	28.02	37.54	-7.41	-10.02
15 (1-1-1-0-1)	0.08	1.52	-0.76	-2.97
16 (1-1-0-1-1)	0	4.80	0	-0.50

In terms of changes in seasonal production of grain amaranth for sale under the HIV+ M scenario compared with the AMAR scenario, all households that reduced sales of grain amaranth reduced their sales by larger amounts in the August to October (second) season than in the February to April (first) season (Table 7-29). However, these households continued to produce more grain amaranth for sale in the second

season than the first season, so sales reductions were by similar proportions for both seasons. Similarly, household 5 increased grain amaranth sales by similar proportions for both seasons, while household 7 was the exception with increased sales of grain amaranth only in the first season in year 3, at the exact time of the initial shock of HIV infection of an adult male.

The most critical difference between Mwatate and Amukura households in seasonal production changes of grain amaranth for sale was that Mwatate households were unable to produce grain amaranth during “middle” season (May to July). This was because the climate of Mwatate followed a strictly bimodal rainfall pattern, with May to July being a distinct dry season, while there was sufficient rainfall to produce a grain amaranth crop in the May to July period in Amukura where the two rainy seasons (February to May and August to November) typically had either a very short or non-existent dry spell in June/July. In Amukura, the largest increases in grain amaranth production for sale under the HIV+ M scenario were in this middle season (May to July) resulting in overall increases of grain amaranth sales for many households. However, without this middle season, sales of grain amaranth in Mwatate under this same HIV+ M scenario do not increase overall.

Changes in sales of agricultural commodities by Mwatate households under the HIV+ adult male scenario

The changes in sales of grain amaranth by Mwatate households under the HIV+ adult male scenario were linked to broader changes in sales of a range of agricultural commodities. Changes in household sales varied considerably highlighting the diversity of household responses to the stress of HIV infection of an adult male (Table 7-30). The

diversity of changes in sales of agricultural commodities was due to the variations in household available resources at the time of initial HIV infection.

Table 7-30. Change in household cash obtained from sales of various agricultural commodities between HIV+ M scenario and AMAR scenario

Household (composition in years 1-4)	Amaranth	Maize	Legumes	Cassava	Beer	Milk	Cow
5 (1-1-0-0-2)	5029	-64331	17838	525	-580	-10329	522
6 (1-1-3-3-1)	-13725	-35103	56443	0	-2857	2815	-5068
7 (1-1-1-1-1)	4945	-57706	-2793	62	-2460	-1579	1527
8 (1-1-2-0-2)	-109137	79087	44081	9504	0	-5512	-2038
9 (1-2-1-1-2)	0	-32230	42841	73	-9404	-9302	-634
10 (2-2-2-2-1)	0	-106673	115290	0	-1512	-18425	-5722
11 (1-1-0-0-0)	-21633	-17866	-69010	5778	-904	-42982	12896
12 (1-1-2-2-3)	-7298	-65998	-37989	7485	-1377	-11611	-7139
13 (2-1-1-0-2)	-78406	28474	-11975	0	519	-875	-5886
14 (1-3-1-2-4)	0	22034	12964	0	-5690	15096	155
15 (1-1-1-0-1)	-16791	30860	-32381	0	-3163	-9587	2279
16 (1-1-0-1-1)	-2268	-8816	-73755	4705	-4473	-6099	754

Three households that were impacted the most under this scenario were households 5, 11 and 16. These households did not have any male youths at the time of initial infection (year 3) which could continue the adult male's tasks while he was sick. These households therefore adopted two different strategies in response to the HIV infection of their adult male. The response of household 5 was to diversify production of sales. This household reduced sales of maize, which was the main crop to which the adult male had previously devoted much of his labor. Meanwhile, the adult female labor that was withdrawn from helping the adult male in maize production was diverted more towards the production of grain amaranth and legumes for both consumption and sale. In contrast, households 11 and 16 reduced their sales of every agricultural commodity as reduced available male labor resulted in reduction of production of agricultural commodities for sale. These households only increased their sales of cassava and

cattle. This highlighted the severe stress under which HIV had put these households. Households typically only increase sales of cattle during times of stress as cattle are a form of both wealth and social status, thus households try to maintain cattle stocks if at all possible. Furthermore, cassava is a low input crop, indicating that HIV infection of an adult male had left these households with very limited resources if cassava was the only crop of which these two households were able to increase sales.

Four households (8, 12, 13 and 15) lacked female youth labor at the time of initial infection, which put these households also under severe stress due to HIV infection of an adult male. As these households only had one adult female to provide necessary labor for the bulk of the food production activities as well as for taking care of the adult male with HIV, these households reduced sales of grain amaranth in favor of producing commodities for sale that required cheaper inputs, such as maize (households 8, 13, 15) or cassava (households 8 and 12). As household 8 had a high land holding to number of household members ratio, it was also able to expand acreage under perennial pigeon peas as another low labor investment. On the other hand, household 12 had a large number of household members, and so had to reduce sales of all commodities except cassava.

Household 7 was the only household that had both a balanced household composition at the time of initial infection and increased sales of grain amaranth. This household had low available land, which resulted in the reduction of sales of all commodities except for grain amaranth which promised quick returns from small acreages. In comparison, households 6, 9 and 10 also all had balanced household compositions at the time of initial infection, yet none of these households produced

grain amaranth for sale under this scenario. These households were not constrained by land or by available youth labor, high income legume sales were increased to compensate for the reductions in grain sales due to the reduction in available adult male labor. Household 14 was the other household that did not produce grain amaranth for sale, and this household was unique in its abundance of available female labor. The reduction in available adult male labor reduced sales of most agricultural commodities in this household in years 3 and 4, so that this household had to remove many of its youths from school for a prolonged period. This had the impact of increasing sales of agricultural commodities from year 5 onwards as the cash saved from not having to pay school fees allowed this household to invest in agricultural activities that generated high levels of cash.

HIV+ adult female scenario

All Mwatate households except 9 and 14 adopted grain amaranth production for sale under the HIV+ F scenario (Table 7-31). This represented an increase of six households on the number of households that adopted grain amaranth production for sale under both the AMAR and HIV+ M scenarios. In addition, all fourteen households that produced grain amaranth for sale under the HIV+ F scenario increased their sales of grain amaranth in comparison to both the AMAR and HIV+ M scenarios. This was similar to the findings in Amukura under this scenario, in which all households adopted grain amaranth production for sale and the majority of households increased sales of grain amaranth in comparison to the AMAR scenario.

Households 9 and 14 were the only ones to not adopt grain amaranth production for sale as both of these households had at least one additional adult female household member. Therefore, when one adult female in these households contracted HIV, the

impact was not as severe as for households which only had one adult female household member. With this additional adult female labor, households 9 and 14 were able to maintain investments in other agricultural commodities for sales and were not under as much stress as other households under this scenario to provide cash quickly such as through the production of grain amaranth for sale. These households could therefore afford to maintain longer term investments for cash generation such as perennial pigeon peas and/or maize-legume rotation patterns.

Table 7-31. Total sales of grain amaranth (bags) for years 2-10 for Mwatate households under the HIV+ F scenario

Household (composition in years 1-4)	Year									
	2	3	4	5	6	7	8	9	10	Total
1 (0-2-2-3-1)	0	2.51	0	0	0	0	0	0	0	2.51
2 (0-1-1-1-1)	0	2.47	3.19	0	0	0	0	0	0	5.66
3 (0-1-1-2-2)	0	0	0	0	0.07	0	0	0	0	0.07
4 (0-1-1-0-1)	0	0.94	0	0	0	0	0	0	0.51	1.45
5 (1-1-0-0-2)	3.78	3.58	3.25	0	0.33	0	1.03	3.73	4.32	20.02
6 (1-1-3-3-1)	0	0	0	0	0	0	0	0	5.44	5.44
7 (1-1-1-1-1)	0	0.18	0	0	0	0	0	3.24	4.08	7.50
8 (1-1-2-0-2)	15.13	12.39	16.44	7.12	10.76	2.76	10.39	10.05	8.53	93.58
10 (2-2-2-2-1)	0	0	0	0	0	0	1.59	17.10	6.82	25.51
11 (1-1-0-0-0)	0	1.51	0.52	0	2.43	0.28	0.78	0	1.79	7.31
12 (1-1-2-2-3)	7.25	1.42	2.36	0	1.05	0	2.75	10.39	11.97	37.19
13 (2-1-1-0-2)	12.55	11.49	12.31	11.03	11.41	10.00	5.55	5.54	4.80	84.68
15 (1-1-1-0-1)	1.60	2.01	0	0	0	0	0	3.31	0.70	7.62
16 (1-1-0-1-1)	0.92	0	2.45	0	2.83	0	1.20	7.24	10.65	25.29

Households 1 and 10 were the other two households in Mwatate that had additional adult female labor. However, this additional labor was not enough to provide for all the youths (and adult males in household 10), so grain amaranth production for sale was crucial for providing necessary cash in times of stress. Household 1 adopted grain amaranth production for sale in year 3 only during the shock of initial infection of

HIV of an adult female, while household 10 produced grain amaranth for sale during years 8 through 10, the years surrounding the death of an adult female.

All other households had only one adult female, so the reduction in available adult female labor due to HIV resulted in these households switching available adult male and youth labor both to increased production for consumption and changing emphasis on which agricultural commodities to sell to meet minimum household cash requirements. All of these remaining twelve households adopted grain amaranth production for sale both through direct production for sale as grain amaranth harvests could generate quick cash returns and through indirect production for sale from surplus of grain amaranth produced for consumption.

Households 8 and 13 still sold the most grain amaranth, as under the AMAR and HIV+ M scenarios. These households were under the most stress as they were unable to meet consumption requirements under the AMAR scenario. The additional stress of HIV resulted in these households adopting grain amaranth for consumption and/or sale throughout every year in order to generate enough food and cash to help meet household requirements. These households both had only one adult female, no female youth, and multiple adult and youth males. This abundance of male labor and lack of available female labor under this scenario were the perfect conditions for households to produce continually high quantities of grain amaranth for sale.

For other households apart from households 8 and 13, grain amaranth production for sale was highest during times of stress (years 3, 9 and 10). This was opposite to the HIV+ M scenario, in which grain amaranth sales were highest during the asymptomatic phase (years 4 through 8). More grain amaranth was sold during times of stress under

this HIV+ F scenario as households depended upon remaining available male labor to generate quick cash from grain amaranth to be used for food production, food purchasing and healthcare for the adult female with HIV. The loss of adult female labor in year 9 also resulted in all households continuing to sell grain amaranth in year 10. The loss of an adult female due to HIV therefore forces households into new patterns of agricultural commodity sales which included selling grain amaranth.

Table 7-32. Comparison of seasonal sales of grain amaranth by Mwatate households (total bags sold years 2-10) under the HIV+ F scenario with sales under the AMAR scenario

Household (composition in years 1-4)	Total under HIV+ F		Change in sales (HIV+ F minus AMAR scenario)	
	Feb-Apr	Aug-Oct	Feb-Apr	Aug-Oct
1 (0-2-2-3-1)	2.51	0	2.51	0
2 (0-1-1-1-1)	5.66	0	5.66	0
3 (0-1-1-2-2)	0	0.07	0	0.07
4 (0-1-1-0-1)	0.94	0.51	0.94	0.51
5 (1-1-0-0-2)	7.89	12.13	5.91	5.67
6 (1-1-3-3-1)	0.66	4.78	0.66	1.73
7 (1-1-1-1-1)	3.41	4.10	3.41	4.10
8 (1-1-2-0-2)	41.77	51.82	7.04	3.56
10 (2-2-2-2-1)	8.46	17.05	8.46	17.05
11 (1-1-0-0-0)	2.84	4.46	2.84	-1.48
12 (1-1-2-2-3)	12.12	25.07	9.95	12.09
13 (2-1-1-0-2)	38.29	46.39	4.86	-3.17
15 (1-1-1-0-1)	4.22	3.40	3.37	-1.08
16 (1-1-0-1-1)	7.77	17.52	7.77	12.22

There was also a clear distinction in the adoption of grain amaranth for sale between FHH and MHH under this scenario. Although all FHH began to sell grain amaranth under this scenario (none had done so under the AMAR scenario), sales of grain amaranth by these FHH were low in comparison to MHH (Table 7-31). This was because the reduction of available adult female labor left these households with very limited supplies of total available labor, thus reducing their ability to produce large

quantities of any commodity for sale. Three of the four FHH produced grain amaranth for sale in year 3 as a means to generate cash quickly at a time of stress. However, none of the FHH had enough remaining available cash or labor to produce grain amaranth for sale following the death of an adult female in year 9.

In terms of seasonal production of grain amaranth for sale, the August to October (second) season continued to be the most important season for the majority of households (Table 7-32). This was because households used the first (February to April) season to generate higher amounts of cash to invest in grain amaranth production in the second season. However, the first season was the most important season for grain amaranth sales for three of the four FHH. These three households sold grain amaranth in the first season of year 3, at the exact time of the initial phase of HIV infection. No other time period was significant for grain amaranth production for sales by FHH.

All households (except household 3 which produced only a very small amount of grain amaranth for sale) increased their sales in the first season, as this season was not as busy as the second season in terms of livelihood activities, so households had more labor available to put towards grain amaranth production for sale. In the second season, however, some households increased while other decreased grain amaranth production for sale. This depended primarily upon available cash and land resources, as labor was constrained for all households during this time of year. Households that had sufficient cash and land resources were able to increase grain amaranth production for sale, while those that were lacking in such resources could not afford to do so.

Changes in sales of agricultural commodities by Mwatate households under the HIV+ adult female scenario

Compared to the changes in sales of agricultural commodities by Mwatate households under the HIV+ M scenario, there was not as much diversity in household responses under the HIV+ F scenario. Although there were similar reductions in sales of agricultural commodities by all households under this scenario compared with the HIV+ M scenario, the impact of an adult female household member contracting HIV was more uniform. This was primarily because when an adult female contracted HIV, sales were generally uniformly impacted among diverse households because females were not as heavily invested in agricultural commodity sales as males. Among diverse households, male labor was therefore typically uniformly withdrawn from certain agricultural sales activities in order to concentrate on production for consumption strategies. In comparison, under the HIV+ M scenario, the reduction in available adult male labor resulted in diverse changes in agricultural commodity sales as households relied on that adult male labor for the sale of agricultural commodities. Thus, when that male labor was suddenly reduced, households changed their agricultural sales in different ways dependent upon available resources.

Overall, the majority of households reduced their sale of agricultural commodities as male and youth labor was withdrawn from sales activities and focused on food production activities in place of the reduced available female labor. Household 14 was the only one able to increase its overall sales of agricultural commodities under this scenario. This was because this household had additional adult female labor and additional cash resources due to having to removing youths from school during times of stress due to HIV.

Households under the most stress due to HIV typically reduced their sales of maize, legumes, beer and milk, while increasing their sales of cassava, grain amaranth and cattle (Table 7-33). Maize was the crop that generated the most cash for all households and its sale depended primarily upon available adult male labor. Maize sales were reduced for all but three households (1, 8 and 15) because available male labor was switched from the sale of maize to food production activities, as available female labor was insufficient, especially at times of stress. Households 1, 8 and 15 increased maize sales at the expense of legume production as HIV infection of an adult female had reduced available cash so that maize was more affordable to produce than legumes.

Table 7-33. Change in household cash obtained from sales of various agricultural commodities between HIV+ F scenario and AMAR scenario

Household (composition in years 1-4)	Amaranth	Maize	Legumes	Cassava	Beer	Milk	Cow
1 (0-2-2-3-1)	11294	25138	-140922	1475	-4959	-18753	5259
2 (0-1-1-1-1)	25469	-33891	-70908	21474	-1499	17975	-4566
3 (0-1-1-2-2)	300	-6132	43097	1714	-1768	-40984	-6022
4 (0-1-1-0-1)	6507	-42574	69937	229	1649	-55218	-4589
5 (1-1-0-0-2)	52142	-42836	-17974	525	-1054	-19206	16269
6 (1-1-3-3-1)	10753	-18410	-2270	0	-7319	5354	-4955
7 (1-1-1-1-1)	33761	-4547	-76269	287	-1728	13961	5423
8 (1-1-2-0-2)	47666	30896	-119559	2122	0	-12587	13424
9 (1-2-1-1-2)	0	-12417	29131	0	-8426	-7822	-503
10 (2-2-2-2-1)	114801	-183777	62724	0	-10366	-1035	-10265
11 (1-1-0-0-0)	6140	-25036	-120556	-626	-3647	-19258	16285
12 (1-1-2-2-3)	99179	-27409	-168148	1087	-2061	-14829	-3902
13 (2-1-1-0-2)	7583	-1277	-173754	0	0	-4836	10720
14 (1-3-1-2-4)	0	-33582	17259	0	-8605	25057	5099
15 (1-1-1-0-1)	10311	5892	-57179	0	-2896	-17801	14032
16 (1-1-0-1-1)	89953	-9673	-157727	50	-5818	-8669	-709

Most households reduced legume sales due to their high labor and cash requirements, which could no longer be afforded due to the stress of HIV. Households 3, 4, 9 and 10 were the only exceptions to this (Table 7-33). Households 9 and 10 had additional available adult female labor, and so were able to increase legume production and sales, which depended primarily on female labor. Households 3 and 4 were FHH and generated additional cash to invest in legume production for sale by removing youths from school. These households were unable to afford school fees in times of stress, and so the additional youth labor combined with school fee savings was used to increase legume production.

Beer sales were reduced for all households as they relied solely on available female labor, which was reduced under this scenario. Beer was produced from sorghum, and with the reductions in available female labor, sorghum was no longer produced by any household under this scenario. Milk sales were also reduced by twelve of the sixteen households. For six of these twelve, reductions in milk sales were directly related to an increase in sale of household cattle. For the other six of these twelve households, the reduction in available female labor alone was enough to reduce milk sales. Households 2, 6, 7 and 14 were the only ones to increase milk sales (Table 7-33). Households 6 and 14 had an abundance of additional available female labor, while households 2 and 7 increased milk sales during the asymptomatic phase (years 4 through 8) when they still had enough female labor available to milk the cows.

Grain amaranth sales increased for all households except households 9 and 14 which had additional available female labor. Grain amaranth provided quick returns on investment despite requiring a relatively high initial cash investment. These increases in

sales went hand in hand with increases in sales of cattle by households under the most stress. Cattle were sold only during times of acute stress as cows were seen as a long term investment and means of insurance against external shocks to a household. Households also under both acute and chronic stress due to the HIV infection of an adult female chose to increase sales of cassava. Cassava required low inputs of both cash and labor, yet also required households to have access to significant land resources which could be set aside for cassava production for up to 18 months per harvest. In particular, FHH increased sales of cassava under this scenario as this was an activity that youths could easily invest in even when the household's only available adult labor was reduced due to HIV.

Summary

The specific attention of this chapter was an assessment of the impacts of HIV infection of an adult household member upon the potential adoption of grain amaranth by diverse households in Amukura and Mwatate. This assessment showed that in order to understand these impacts upon potential adoption of grain amaranth, it was also important to assess the impacts upon the whole livelihood system and the changes in the diverse strategies adopted by households in both communities. Attention was especially given to analyzing the differences in potential adoption of grain amaranth among 1) diverse households, 2) different communities, and 3) different HIV scenarios – an adult male contracting HIV or an adult female contracting HIV. This section pulls this assessment together by highlighting the key findings of this chapter.

Impacts of HIV upon Household Food Security

In both Amukura and Mwatate, when an adult female contracted HIV households were more food insecure than when an adult male contracted HIV. As food production

in both communities was primarily in the female domain, household food insecurity was increased to a greater extent due to reductions in available adult female labor than to reductions in available adult male labor. Furthermore, the initial phase of HIV infection (year 3) and the years following the death of an adult due to HIV (years 9 and 10) were the times of greatest food insecurity for households in both communities.

The major difference between the food security of Amukura and Mwatate households was that Amukura households struggled more to provide enough protein to meet minimum consumption requirements, while Mwatate households struggled more to provide enough calories to meet minimum consumption requirements. This was due to the available livelihood strategies in each community's livelihood system – Mwatate households had more legume options which were more important for protein provision, while Amukura households had more grain options which were more important for providing calories.

In both communities and under both HIV+ scenarios, households that had low consumer-producer ratios were able to maintain food security by meeting minimum consumption requirements every year. Meanwhile, under both HIV+ scenarios, food insecurity of a household was more severe in either community dependent on the incidence of the following four factors: 1) consistently high consumer-producer ratios, 2) unbalanced gender household compositions (i.e. considerably more males than females, or vice-versa), 3) lack of available land, and 4) pre-existing food insecurity under the AMAR scenario.

Impacts of HIV upon Household End Cash

In both communities and under both HIV scenarios, all households had reduced end cash in year 10 compared with the AMAR scenario. This highlights that HIV

infection of an adult household member does not only impact household labor supply, but also household cash supply. Reductions in end cash for a specific household were dependent upon available household resources at the time of initial infection as well as its consumption, end cash and school fee requirements. Households with the highest consumer-producer ratios had the biggest reductions in end cash in year 10 under the HIV+ scenarios in Amukura. In Mwatate, the households with the biggest reductions in end cash in year 10 under the HIV+ scenarios were those with the lowest supply of adult labor over time and the highest end cash under the AMAR scenario (thus, the households with the most cash to lose). End cash in year 10 was reduced less for FHH than MHH in both communities under both HIV+ scenarios. This was due mainly to FHH having lower end cash totals under the AMAR scenario (and so, less cash to lose) and to FHH being less involved in cash generating activities due to their lack of available adult male labor.

More youths were removed from school under the HIV+ F scenario than under the HIV+ M scenario in both communities. This was because female youths were removed from school before male youths. Therefore, under the HIV+ F scenario, when households were lacking in available female labor, the removal of female youths from school provided households with additional necessary female labor for food production. Under the HIV+ M scenario, youths were removed from school more due to the cash that could be saved from not having to pay school fees, rather than any specific household labor needs. In addition, more youths on average were removed from school by Mwatate households than by Amukura households. This was because Mwatate households typically had lower available cash at the time of initial HIV infection (year 3),

when most of the removals of youths from school occurred. Households in Mwatate thus had a greater need for additional cash in year 3 than Amukura households, resulting in more youths on average being removed from school during years 3 and 4. The removal of youths from school was typically not permanent, however. Most of these households were able to recover sufficiently by year 5 to have enough available cash to put youths back in school, and were able to plan for the death of the adult living with HIV in year 9 by saving enough cash to keep youths in school in years 9 and 10.

Impacts of HIV upon Potential Household Adoption of Grain Amaranth

Under both HIV+ scenarios in both Amukura and Mwatate, there was greater potential for households to adopt grain amaranth as a cash crop than as a food crop. Modeling of household responses to HIV indicated that the value of grain amaranth in terms of potential cash benefit to a household outweighs the potential consumption benefits. All households that consumed grain amaranth also sold grain amaranth, while there were also some households that only produced grain amaranth for sale and not for consumption. Therefore, although both consumption and sales of grain amaranth were important for certain households in both communities in the context of HIV infection of an adult member, the production of grain amaranth for sale was more widely adopted than the production of grain amaranth for consumption.

As grain amaranth was relatively high in essential proteins for household diets compared with the amount of calories it offered, grain amaranth was more likely to be adopted by households struggling to meet minimum protein requirements than households struggling to meet calorie requirements. The Mwatate livelihood system had more high protein options available to households for production (especially legumes) than the Amukura livelihood system. Therefore, as Amukura households were typically

more protein-constrained, more households in Amukura than Mwatate adopted grain amaranth production for both food and sale.

Consumption and sales of grain amaranth by households in both communities were greater under the HIV+ F scenario than under the HIV+ M scenario. Not only did more households adopt grain amaranth production for consumption and/or sale, but more grain amaranth was consumed within or sold by each household that adopted grain amaranth production under the HIV+ F scenario than under the HIV+ M scenario. Both household consumption and sales of grain amaranth were greater under the HIV+ F scenario than under the AMAR scenario. Meanwhile, household consumption was less and sales of grain amaranth did not change under the M scenario compared with the AMAR scenario. Households are therefore more likely to adopt grain amaranth production when an adult female contracts HIV than under either the HIV+ M or AMAR scenarios. Therefore, the reduction in available adult female labor leads to more severe changes in how households organize their remaining available resources for production. This is because the adult female(s) in a household is the primary person(s) responsible for managing food production. The reduction in available adult female labor directly affects both food production and cash generating activities, by drawing household male and youth labor into a much larger role in food production and away from cash generating activities. This leads to significant changes in household investments in both food production and cash generating activities. In comparison, under the HIV+M scenario, the reduction in available male labor only indirectly affects the main food production of the household. Under this scenario, cash generating activities are directly affected, while the household is not under as much pressure (as under the HIV+ F

scenario) to significantly change food production activities to include grain amaranth production.

Linked to the higher potential for adoption of grain amaranth production under the HIV+ F scenario compared with the HIV+ M scenario is that household production of grain amaranth only continued in year 10 (the year after the death of an adult member) under the HIV+ F scenario. This indicates that the restructuring of household compositions due to the loss of an adult female leads to a reorganizing of household production activities that is more likely to include grain amaranth production than a reorganizing of production activities in year 10 under the HIV+ M scenario. This indicates that grain amaranth is not only more likely to be adopted by households under the HIV+ F scenario, but also that production of grain amaranth is more likely to be maintained even following the death of an adult female.

Increases in and totals of grain amaranth production for consumption and sales were highest for all households under both HIV+ scenarios during times of greatest stress, i.e. year 3 and years 9 and 10. At these times, households had higher consumer-producer ratios and faced increasing food insecurity. Due to grain amaranth's ability to produce reliable harvests on small plots of land in a short period of time, grain amaranth was a useful livelihood strategy for households to adopt in times of stress when an immediate boost in food production or cash from sales were required to help households maintain food security. However, the main limitation to adoption of grain amaranth during times of stress was the necessary cash to initiate production due to the relatively high cost of grain amaranth seed. In addition, the only exception to the overall pattern under both HIV+ scenarios was for production of grain amaranth for sale under

the HIV+ M scenario in Mwatate. Under this specific scenario, households were unable to increase or maintain high levels of grain amaranth production for sale due to their lack of available male labor. Therefore, overall, households were more likely to adopt grain amaranth production as a livelihood strategy during times of stress if they had high consumer-producer ratios and low available land area, while also having enough available cash and sufficient available male labor.

Two other factors were also important in understanding whether or not a household would adopt grain amaranth under these HIV+ scenarios. First, households that were under pre-existing food security stress were more likely to adopt grain amaranth for both consumption and sale. All households in both communities that failed to meet consumption requirements without HIV had already adopted grain amaranth. HIV infection of an adult member put these households under increased stress, and reinforced their decisions to produce grain amaranth in attempts to increase household food security. Secondly, male-headed households (MHH) were more likely to adopt grain amaranth production than female-headed households (FHH). This was primarily due to the lack of adult labor that FHH could provide towards agricultural production. Under the HIV+ F scenario, available adult labor was more severely reduced in FHH than in MHH because MHH on average had more adults in their households.

Seasonal production of grain amaranth for both Amukura and Mwatate under both HIV+ scenarios generally followed similar patterns to the seasonal production under the AMAR scenario. In Amukura, production of grain amaranth for consumption was highest during the August to October (second) season, while in Mwatate, production of grain amaranth for consumption was highest during the February to April (first) season. In

contrast, the opposite seasons in both communities were the most important for grain amaranth production for sale – for Amukura the first season was more important for sales, while in Mwatate the second season was more important for sales. These opposite seasons were more important for sales as these were the main times when households had enough available cash to invest in higher production of grain amaranth. Mwatate households had more available cash in the second season following sales of first season maize and legumes, while Amukura households had more available cash in the first season as this season generally followed the sale of sugar cane, the most important cash crop in Amukura. Overall, this therefore indicates that households devised clear strategies for production of grain amaranth by season dependent primarily upon available cash resources.

HIV infection of an adult member in a household also had impacts upon the adoption of other livelihood strategies apart from grain amaranth for production of food and/or cash. In general, the consumption and sale of most agricultural commodities was reduced under both HIV scenarios due to the reductions in available household labor and cash to invest in production. However, there were certain exceptions to this overall pattern, which were characteristic of households struggling due to HIV. In terms of consumption, Amukura and Mwatate households increased consumption of sorghum under both HIV+ scenarios as sorghum was cheap to produce and required low labor inputs yet still provided more protein by weight than either maize or finger millet. Under the HIV+ M scenario, many households increased sorghum consumption instead of grain amaranth production due to lack of available cash for grain amaranth, while under the HIV+ F scenario, household sorghum consumption typically increased together with

increases in grain amaranth consumption. In addition, in Mwatate only, households with sufficient available cash and land resources were able to increase consumption of legumes such as pigeon peas in order to counteract the reductions in consumption of other important foods. In terms of sales, households in both communities increased sales of cattle in order to generate additional cash to help meet minimum end year cash requirements. Households also increased sales of cassava, as this became the only crop that could be produced on a large scale under the stress of HIV due to its very low labor and cash input requirements. In Amukura only, sugar cane sales were reduced for most households, yet those that had both sufficient available land and multiple adults to shoulder the impact of HIV infection of an adult member were able to increase sugar cane sales.

Conclusions

The findings of this chapter brought to the fore several important points which are crucial in understanding the potential for adoption of grain amaranth production by HIV/AIDS-affected households in rural Kenyan communities. First, it is critical to note that the impacts of HIV upon diverse households are not uniform. Diverse households have different available resources of land, labor and cash which lead to different responses to the infection of an adult member with HIV. Households are more apt to adopt grain amaranth production under both HIV scenarios if they have several of the following characteristics:

1. High consumer-producer ratio
2. Lack of available female labor but available male labor
3. Low land availability
4. Sufficient available cash
5. Male-headed
6. Pre-existing food insecurity when not under HIV stress

7. Greater difficulty in meeting protein consumption requirements than calorie consumption requirements

The potential for adoption of grain amaranth by households within a community also depends upon who contracts HIV within a household. The potential for adoption of grain amaranth by a household is greater when an adult female contracts HIV than when an adult male contracts HIV. In addition, households are more likely to continue to produce grain amaranth following the death of an adult female than following the death of an adult male. The consequences of a household losing an adult female to HIV/AIDS are both more permanent and more severe than those following the death of an adult male in terms of overall household food security.

However, this is not to downplay the impacts of an adult male contracting HIV upon household food security. In fact, under both HIV+ scenarios, the impacts of HIV are devastating upon households, with some even facing 60% reductions in calorie and/or protein consumption. Such reductions may not even be feasible, and it is highly likely that some households will break up under the pressure of HIV, especially under times of acute stress such as during the initial phase of infection or following the death of an adult. If households are able to weather the storm of the initial phase of infection and the adult member with HIV is able to recover to a physical state whereby he/she is reasonably productive during the asymptomatic phase, then a household's future typically rests on both the length of the asymptomatic phase and the ability of the household to reorganize and reprioritize its livelihood strategies so that the household is able to bear the shock of the death of the adult member.

The potential adoption of grain amaranth production also varies between communities. Although there were multiple reasons underlying the differences in

potential for adoption of grain amaranth between households in Amukura and households in Mwatate in the context of HIV, two primary reasons were identified. First, the Amukura livelihood system contained fewer agricultural production strategies for high protein crops than Mwatate. This was due both to what seeds were available to households in each community and to the influence of climate upon crop production decision-making. Households in Amukura were typically less able to provide sufficient dietary protein than households in Mwatate due to the lower variety of high protein legume options. Therefore, with HIV infection of an adult member reducing both household available cash and labor, households were put under increased consumption stress. In Amukura, this consumption stress was primarily protein deficiency, while in Mwatate this consumption stress was primarily calorie deficiency. As a result, households in Amukura were more apt to adopt grain amaranth as a strategy to increase protein consumption and thereby improve food security. Secondly, the Amukura climate enabled the possibility of grain amaranth production three times per year, while the Mwatate climate had more distinct wet/dry seasons, permitting the production of only two grain amaranth crops per year. Households in Amukura therefore had more options of times to produce grain amaranth in any given year than Mwatate households, increasing the potential for adoption. This was especially important in the context of HIV, as available labor for most households was at a premium, so increased chances to produce grain amaranth led to increased potential for its adoption.

Overall, grain amaranth has significant potential to be adopted by the majority of households in a community under both HIV scenarios. Grain amaranth has an important role to play in assisting households to maintain food security. The benefits of grain

amaranth being both a nutritious food and a viable cash generating crop are very important to HIV/AIDS-affected households. Chapter 8 will bring this discussion to a close not only by summarizing the various conclusions from each of these four discussion chapters (Chapters 4 through 7), but also by highlighting recommended ways forward for improving the grain amaranth extension effort and maximizing the potential for adoption of grain amaranth by HIV/AIDS-affected households in both these (Amukura and Mwatate) and other communities in rural Kenya.

CHAPTER 8
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The overall goal of this research was to investigate whether grain amaranth production is a feasible livelihood strategy for diverse limited-resource households in rural Kenyan communities. The main objectives of this study were therefore first to examine the potential for adoption of grain amaranth by limited-resource households in rural Kenyan communities within the context of their existing livelihood systems, and secondly to examine the impact of HIV infection of adult household members upon the potential adoption of grain amaranth by these households. Two rural communities were selected for this study – Amukura, Teso District in western Kenya and Mwatate, Taita-Taveta District in south-eastern Kenya. These communities were selected because they both had ongoing grain amaranth extension efforts coordinated by CRWRC and because they provided a useful contrast of rural Kenyan communities in terms of a range of environmental and socio-cultural conditions.

In order to achieve the two main objectives, four research questions were drawn up and each was examined in turn in Chapters 4 through 7. Before the potential adoption of grain amaranth by households in these communities could be examined, it was important to examine the current livelihood systems of Amukura and Mwatate (Chapter 4) in order to understand the context into which grain amaranth was being introduced. Furthermore, it was important to assess the acceptance of grain amaranth by both communities (Chapter 5) before analysis of potential adoption (Chapters 6 and 7), as acceptance is a prerequisite for adoption. The research questions were therefore as follows:

1. What are the current livelihood systems of the two communities (Amukura and Mwatate) and the current livelihood strategies adopted by diverse households within these communities?
2. What are the social attitudes towards grain amaranth in Amukura and Mwatate?
3. For which kinds of household is grain amaranth production a feasible livelihood strategy option in these communities?
4. What is the impact of HIV/AIDS upon the potential adoption of grain amaranth as a livelihood strategy by diverse households in these communities?

This final chapter first highlights some of the overall limitations to this study, before assessing the findings in response to these four questions and provides some general conclusions on the types of rural Kenyan households most likely to adopt grain amaranth as a livelihood strategy option. Following these conclusions, recommendations are provided as practical ways forward for those working in grain amaranth extension efforts. It is hoped that these recommendations can improve the effectiveness of both ongoing and future grain amaranth extension efforts. Such an improvement would be beneficial to both extension workers and the rural households that stand to benefit from grain amaranth production.

Study Limitations

In Chapter 3, a discussion of the research validity was given, highlighting some of the major challenges to be overcome when conducting this research study. This section reiterates the most important limitations that were mentioned in Chapter 3 as well as discussing other important limitations to that emerged throughout the course of conducting this research.

This study was undertaken with the approval and logistical assistance of the Christian Reformed World Relief Committee (CRWRC) and its main partner in the field, the Anglican Church of Kenya (ACK). These organizations already had a positive view of grain amaranth and were actively promoting the adoption of grain amaranth in the two studied communities. Being aware of this, research methods and analysis were

developed in order to reduce bias toward grain amaranth and to increase objectivity of results and conclusions. This was accomplished through the use of Ethnographic Linear Programming (ELP) to uncover patterns of household decision making concerning grain amaranth, in order to identify which households were likely and which households were unlikely to adopt grain amaranth as a livelihood strategy. This modeling approach used objective raw data gathered from households in each community, and in no model scenario was any household forced to choose grain amaranth adoption.

Related to this issue, the Community Development Facilitator (CDF) in each community was the direct link to each household selected for interview. Although a translator from outside of each community was hired (though still a native speaker of either Kiteso or Kitaita), the association between the CDF and this research study may have affected certain information that was collected. In particular, responses concerning attitudes towards and general acceptance of grain amaranth were influenced by the relationship between the CDF and community members – this was discussed in detail in Chapter 5. However, the use of ELP as an objective tool for analysis generated patterns of household adoption of grain amaranth that were not biased due to the relationship between a household and the CDF.

As a white, non-Kenyan outsider to both communities, community perceptions about my role were also a limitation to this study. This was overcome by spending as much time in the community as possible even in a non-researcher role. I took up residence in or nearby each community, engaging in local markets for my daily food and spending time with households to build up trust. Ideally, more time could have been spent in these communities, including spending time throughout each season in an

annual cycle. In this study, as much time as possible was spent in the field in relation to available time and funding.

It may also be argued that the sample size of sixteen households in each community was too small to generate meaningful results or to generalize results to other communities. However, large sample sizes are not required when using referral sampling or when specifically looking to assess the diversity among households within a community. The sampling strategy adopted enabled the identification of a set of households in each community that were representative of the diversity found in that area. This emphasis on diversity of households enabled results to be generalized to other communities as a wide range of household scenarios was examined, which would likely be found in any other potential community of study. Any further increase in sample size would have unlikely generated a proportional increase in diversity of households. In addition, the methodologies utilized in this study were time intensive and precluded the interviewing of a much larger sample of households.

Current Livelihood Systems (BASIC Scenario)

The current livelihood systems of Amukura and Mwatate were described through data collected from focus group discussions and semi-structured interviews with household members. Seasonal calendars were an especially useful participatory tool employed to gather livelihood system data. In order to analyze the decision-making processes of diverse households within each livelihood system, ethnographic linear programming models (ELPs) were constructed from both the collected field data and secondary sources. Before analyzing the potential adoption of grain amaranth, household decisions were analyzed using a basic ELP (BASIC scenario). Descriptions of the livelihood systems and the ELP BASIC scenario analysis are in Chapter 4.

Amukura

Households in Amukura based their production for consumption around cassava and maize, the primary staples of Amukura meals. There were distinct differences between male-headed households (MHH) and female-headed households (FHH) in terms of adoption of livelihood strategies for household consumption. Whereas MHH based their production for consumption predominantly on cassava and maize and a mix of beans and groundnuts, FHH based their production for consumption on cassava, a mix of grains, including maize, sorghum and finger millet and groundnuts as the main legume. These differences in livelihood strategy adoption were related to both the household composition of labor and the gender-specific domains of each crop. Maize was considered a male crop, while sorghum, finger millet and legumes were considered female crops. Meanwhile, although all households sold some surplus of various food crops, sugar cane dominated household production for sale. As sugar cane was considered a male crop, MHH in general produced more sugar cane than FHH. This resulted in FHH being less cash secure than most MHH.

In comparison to households in Mwatate, Amukura households struggled more to meet consumption requirements under the BASIC scenario. Seven households out of sixteen failed to meet consumption and/or cash requirements. Out of these households, four had to reduce food consumption, one had to remove youths from school, and two had to conduct both strategies. The biggest problem for Amukura households was providing sufficient protein for household consumption. This was mainly due to the high labor and cash cost of producing legumes - typically the main high-level protein source in a rural Kenyan diet - that in turn led Amukura households to produce only small quantities of legumes for consumption.

Mwatate

Households in Mwatate based their production for consumption around maize and legumes, including pigeon peas, groundnuts and beans. Households with plentiful available female labor were able to produce a diverse range of legumes in order to spread risk, as female labor was essential for legume production, especially in the post-harvest phase. Other households were unable to spread this risk and adopted either beans or pigeon peas as their primary legume for consumption. This was due to both requiring less labor and cash to produce than groundnuts.

A major distinction between the Mwatate and Amukura livelihood systems was that in Mwatate there was no dominant cash crop, unlike sugar cane in Amukura. Although sisal plantations were common in the area, resource-limited households rarely invested in sisal production for sale. Instead Mwatate households sold surplus of a range of crops, including maize and a range of legumes, as well as animals and their products, especially cattle and milk. Due to the lack of a dominant cash crop, the majority of households were constrained by available end cash. This meant that there were few differences between MHH and FHH in terms of either end-of-year cash or household production, as the majority of households had very low amounts of available cash to invest in production. Out of the eight households that did not meet requirements, six were unable to meet school fee requirements, while two were unable to meet both school fee and consumption requirements. Therefore, while more households in Mwatate were food secure than households in Amukura, more households in Mwatate were unable to meet end cash requirements, resulting in the removal of more youths from school.

Both Communities

Findings from ELP BASIC model runs demonstrated the range of livelihood strategies adopted by diverse households in each community due to the differences in available household resources. Livelihood strategies adopted changed over time in line with dynamic household compositions and in response to changes in household availability of land and cash. The findings of this study underline the importance of household composition as a key variable in influencing decisions about livelihood strategies, as highlighted in Cabrera *et al*.'s (2005) study. In particular, the gender composition of a household and the delineation of gender-specific tasks were crucial factors to consider when analyzing diverse household decisions. This lends weight to the argument of Francis (1998), who argued that gender interdependencies were critical to household decisions about livelihood strategies. All households in both communities were especially constrained by land throughout the year and by labor in critical crop production seasons (February-April and August-October). Households had the option to both rent and buy land to increase available land area, and these were more feasible options in Amukura than in Mwatate due to the relative costs of renting/purchasing land between the two communities. Mwatate land was particularly expensive as fertile, well-watered land was at a premium due to having a drier climate than Amukura. The primary labor constraint for all households was available female labor, as this could not be hired unlike adult male labor. In general, households with lower amounts of available female labor were the most food insecure, as female labor was critical for household food production. Meanwhile, not all households were cash constrained, as this constraint depended predominantly on household composition. End cash in year 10 was strongly negatively correlated with the consumer-producer ratio of a household in both

communities. This indicated that households with a higher proportion of dependents were more cash constrained, while households with more adults and fewer dependents were unlikely to have available cash as their major constraint.

Acceptance of Grain Amaranth

A household must accept grain amaranth as a potential livelihood strategy before it can adopt grain amaranth production. Therefore, Chapter 5 analyzed community attitudes towards grain amaranth in both Amukura and Mwatate. Data on community attitudes were collected primarily via focus group discussions, which revealed that attitudes rest on three spheres of influence: socio-cultural, bio-physical, and economic. Socio-cultural factors were the most important in influencing the acceptance of grain amaranth in both communities. These factors included prior knowledge of amaranth, the methods of communication about grain amaranth, the source of grain amaranth information, and cultural concepts of grain amaranth including community myths and the traditional role of amaranth in a proper Kenyan meal.

Grain amaranth began with an advantage in these communities compared with other potential innovations because amaranth was not new to Amukura and Mwatate households, but was already known as a vegetable called *mchicha*. Grain amaranth promotion efforts therefore had a foundation from which to work, without having to introduce a completely foreign crop. Building upon this foundation, multiple methods of communication about grain amaranth have been employed in both communities. These included field days, cooking demonstrations, individual extension visits, focus groups and community workshops. The main organizer of these activities was the Community Development Facilitator (CDF), employed by the rural development branch of the Anglican Church of Kenya. This CDF was therefore also the main source of grain

amaranth information in a community and his/her relationship with community members had a direct impact upon the acceptance of grain amaranth.

Households in both communities held a common cultural concept that vegetable amaranth (*mchicha*) occupied a fringe role in a proper Kenyan meal. Key to the acceptance of grain amaranth by households was their ability to shift amaranth from its fringe role as a vegetable to a core role as a grain. The focus of promotion efforts on mixing grain amaranth with other grains to make *ugali* helped households overcome this hurdle to acceptance. Meanwhile, differing community myths surrounding grain amaranth in each community played an important role in either encouraging or discouraging households from accepting grain amaranth. In particular, myths associating grain amaranth with HIV/AIDS led to the stigmatizing of grain amaranth and consequently increased barriers to acceptance.

On the other hand, the biophysical influences of taste and health/nutrition helped to break down these barriers. Food tasting and cooking demonstrations led to increased acceptance of grain amaranth as community members enjoyed the taste of grain amaranth. In addition, the promotion of the nutritional benefits of grain amaranth consumption through extension efforts have increased community acceptance, especially when validated by the testimonies of friends or trusted neighbors who have consumed grain amaranth in the past and believe to have received health benefits from its consumption.

Economic factors affecting acceptance were also important considerations for households in both communities. Benefits included the relatively low resource inputs required for grain amaranth production, the potential for multiple crops per year, and the

ability of grain amaranth to be prepared in a much shorter time period compared with legumes (the other major protein dietary source). However, even with relatively low resource requirements, the majority of households still faced the barrier to acceptance of whether or not to invest in a crop that did not have a long history of success in their communities.

Overall, grain amaranth was more widely accepted by Amukura households than Mwatate households. This was due to a variety of reasons, of which the most significant were the source of grain amaranth information and the incidence of HIV. Grain amaranth promotion efforts were more actively pursued using a variety of methods by the CDF and even other agencies in Amukura compared with Mwatate. Hence, grain amaranth had a much higher profile and more households were aware and accepting of grain amaranth in Amukura. The higher incidence of households affected by HIV in Amukura also increased community desire in that community to consider alternative consumption practices such as grain amaranth. Households in Amukura were thus looking for ways to combat HIV to a greater extent than Mwatate households.

The Potential Adoption of Grain Amaranth Production (AMAR Scenario)

The AMAR scenario built upon the discussion and analysis in Chapters 4 and 5 by directly addressing the potential for adoption of grain amaranth production. This was specifically achieved through incorporating grain amaranth as an additional livelihood strategy option for households to consider in the BASIC ELP, resulting in the creation of the AMAR scenario.

The AMAR scenario revealed both commonalities and differences between households in Amukura and those in Mwatate on the potential adoption of grain amaranth. Grain amaranth production was not universally adopted by households in

either community. Out of the sixteen households in each community, nine in Amukura and two in Mwatate adopted grain amaranth production for both consumption and sale, while an additional five in Amukura and an additional six in Mwatate adopted it for sale only. Households were more apt to adopt grain amaranth if they fell into one or more of three categories:

1. Lacking in sufficient protein intake, especially if getting enough protein into the diet was more problematic than getting enough calories. This was because grain amaranth was high in protein and could provide households struggling to meet minimum protein requirements with the additional protein needed.
2. Gender imbalanced, especially if available female labor was lacking at the same time as male labor was plentiful. As women were primarily responsible for household food production, households with plentiful available female labor had little incentive to switch from their current investments (in the BASIC scenario) to a new crop (grain amaranth). Households that were lacking in available female labor had to rely upon available male labor to assist with food production activities. Grain amaranth was the one crop that was not gender domain specific (hence, all grain amaranth tasks could be performed by both men and women); it was an attractive livelihood strategy option for households lacking in female labor but having plenty of male labor.
3. At times of most stress due to interactions of resource availability and constraints, in particular when a household was most food or cash insecure. This was mainly due to the quick return on investment from grain amaranth due to the relatively short time it took from planting to harvest.

Two other patterns were identified among households in both communities. First, households that consumed grain amaranth also had higher sales of grain amaranth. This was because those households that produced grain amaranth for consumption had already invested in grain amaranth as a livelihood strategy and hence sold any surplus that they did not consume. This also confirms that households that consume it are more likely to have widely accepted grain amaranth as a viable livelihood strategy, leading them to be more likely to invest in greater production for sale than other households that did not consume it and reap the consumption benefits.

Secondly, the potential adoption of grain amaranth decreased for all households over time as available end cash increased. As households had more available cash, they switched from grain amaranth production to strategies with a higher return on investment, whether that return was in terms of cash or consumption benefits. In Amukura, households increasingly switched to sugar cane production, as this could generate more cash per acre than grain amaranth. In Mwatate, households increasingly switched to high-value legume production, which could generate both more cash and more protein per acre than grain amaranth. Both sugar cane and high value legumes required substantial initial investments in comparison to grain amaranth, so were only more viable options once households had more available cash. This suggests that grain amaranth is only an attractive option for households that are struggling, and once households have enough available cash, they will discontinue grain amaranth production. However, limited-resource households such as those modeled here are seldom at a period where they are not under some form of stress (such as HIV). Moreover, the market for grain amaranth in Kenya is still developing and relatively new, and with expanded market opportunities, incentives to produce grain amaranth may increase.

As already noted, more households in Amukura than Mwatate adopted grain amaranth production. This was due to four major differences between Amukura and Mwatate households and their livelihood systems:

1. Households in Amukura had fewer high protein food options available in their livelihood system than Mwatate households. Therefore, grain amaranth was an attractive source of protein to help households meet minimum protein requirements. Meanwhile, households in Mwatate struggled more to meet minimum calorie requirements than protein requirements as they had plenty of high protein legume options available, such as pigeon peas, groundnuts, beans and cowpeas.

2. Mwatate households did not generate as much available cash as Amukura households due to the lack of a major cash crop such as sugar cane. Therefore, Mwatate households had less available cash to invest in a new livelihood strategy – grain amaranth.
3. The prices of renting and buying land in Mwatate were significantly higher than those in Amukura. Therefore, Mwatate households had fewer opportunities to expand their available acreage in order to create a space for grain amaranth production as an additional livelihood strategy option.
4. Mwatate households typically invested heavily in pigeon pea production as their main protein source and a major source of income. Pigeon peas were planted every other year, resulting in second year yields that were lower than first year yields. Grain amaranth production was therefore adopted by Mwatate households only to a significant extent in the second year of pigeon pea production as in those years it could provide a better protein and cash return on investment than pigeon peas. Amukura households did not have as much competition for grain amaranth production as Mwatate households, resulting in a more continuous pattern of production over time.

The adoption of grain amaranth production by households in Amukura and Mwatate impacted household decisions about other livelihood strategies. Households that were food insecure and consequently consumed grain amaranth were the ones that changed their livelihood strategies the most. These households were able to improve food security by consuming grain amaranth and by selling grain amaranth in order to generate cash to invest in producing or purchasing other foods. For other households, changes in livelihood strategies were not as great, and were diverse and dependent upon available household resources. Grain amaranth adoption led to reductions in sales of most crops by households in both communities, as households switched to selling grain amaranth. The exception to this was in Amukura, where grain amaranth sales facilitated an increase in sugar cane sales. In terms of consumption, grain amaranth adoption mostly resulted in changes in legume production for consumption as households realigned their strategies for providing protein in their diet. In Amukura, households either reduced their legume consumption as grain amaranth partially replaced legumes in the diet or diversified legume consumption using cash generated

from grain amaranth sales. In Mwatate, households increased production of beans for consumption as these could be intercropped with maize, thus making land that was previously under solecropped legumes available for grain amaranth production.

Therefore, this chapter highlighted that the potential for grain amaranth is more as an alternative livelihood strategy than an additional one. This is primarily because households in rural Kenyan communities such as Amukura and Mwatate are already severely resource limited by some combination of land, labor and cash. These households seldom have additional available land, labor or cash to produce grain amaranth, thus if grain amaranth is adopted it is in the place of, rather than in addition to, existing livelihood strategies.

Grain amaranth was adopted by the majority of Amukura households and half of the Mwatate households under the AMAR scenario. This indicates that there is significant potential for grain amaranth production in rural Kenyan communities. This potential depends on the community itself, including the potential role of grain amaranth within the community's livelihood system and the cultural practices embedded in this system such as the gendered division of labor. This potential also depends on households within the community and the resource availability that these households have at any given time.

The Impact of HIV upon the Potential for Adoption of Grain Amaranth (HIV+ Scenarios)

The analysis in Chapter 6 was extended in Chapter 7 to account for the contraction of HIV by either an adult male or an adult female in diverse households in each community. As both Amukura and Mwatate households were widely affected by HIV/AIDS, this addition to the AMAR ELP made simulations more realistic. Furthermore,

the simulation of both HIV+ scenarios generated patterns of HIV impacts upon livelihood strategy decisions – in particular, grain amaranth adoption – that could inform extension workers about expected impacts in other rural Kenyan communities, the vast majority of which are affected by HIV/AIDS.

The contraction of HIV by an adult household member resulted in overall negative impacts upon all households in both communities, including reduced available labor and reduced available cash. Households also faced increased consumption requirements to minimize the physical impacts of HIV, as the physical stress of HIV on a person demanded that person increase intake of calories and protein. However, the severity of these impacts upon household livelihood strategy decisions were not uniform but were diverse depending upon differences in households' availability of resources. Households in both communities that were more food insecure under either HIV+ scenario fell into one or more of the following categories:

- Consistently high consumer/producer ratio (>2.50) over time. This put certain households under more stress than others, multiplying the stress of HIV, and making it difficult for them to meet minimum consumption and cash requirements
- Unbalanced gender composition. The lack of either female or male labor in a household resulted in an inability to perform certain gender-specific tasks for some livelihood activities. This forced these households to either adopt strategies with poorer returns on investment or strategies that required a larger initial resource investment, resulting in fewer available resources and decreased food security. In households with only one adult male and one adult female, the contraction of HIV by one of these adults quickly leads to unbalanced gender availability of labor.
- Lack of available land. Households that were land constrained were unable to generate as much food or cash from sales as land-rich households, leaving them more vulnerable to food insecurity under the stress of HIV.
- Pre-existing food insecurity under the AMAR scenario. Households that were already failing the meet minimum consumption requirements under the AMAR scenario were put under increasing stress with an adult living with HIV. This made such households even more susceptible to food insecurity.

However, the impact of HIV infection of an adult member upon the adoption of grain amaranth was more diverse than the overall impacts upon household labor, cash and consumption requirements. Grain amaranth was a viable food and cash crop livelihood strategy for some, but not all households under both HIV+ scenarios. Households falling into one or more of seven categories were more apt to adopt grain amaranth in the context of an adult contracting HIV:

1. High consumer/producer ratio (>2.50). Consumer/producer ratios fluctuated over time for each household. Households were more likely to adopt grain amaranth during times of high C/P ratio, as grain amaranth provided a quick return on investment in these times of stress.
2. Lack of available female labor but available male labor. When households lacked available female labor, grain amaranth was the most attractive livelihood strategy for providing high levels of protein into a household diet. This was because the other main sources of protein in the livelihood system were legumes, which required a high level of female labor input. However, households still needed sufficient labor to carry out grain amaranth production tasks, so enough available male labor was required for households to adopt grain amaranth production.
3. Low land availability. Grain amaranth required neither large land areas, nor land for a long period of time due to its short time from planting to harvest. Grain amaranth production was therefore more attractive to households which had only small areas of land available and did not have large acreages devoted to long term investments such as sugar cane (in Amukura) or cassava.
4. Sufficient available cash. Grain amaranth seed was relatively expensive compared to seed of other grain crops in both communities. Therefore, grain amaranth production required a significantly greater initial cash investment than other grain crops. Households therefore needed to have access to sufficient cash to begin producing grain amaranth.
5. Male-headed household. Grain amaranth was adopted more by male-headed households than female-headed households. Male-headed households always had a combination of adult males and females. Thus, when one adult contracted HIV, there was still sufficient available adult labor to produce grain amaranth. However, for female-headed households, once an adult female contracted HIV, there was very little or no available adult labor. This forced these FHH into a focus on low-input cropping strategies such as sorghum or finger millet, as they only had youth labor available. This lack of available labor in the context of HIV also resulted in FHH having fewer opportunities to generate sufficient available cash to begin grain amaranth production.
6. Pre-existing food insecurity when not under HIV stress. Households that were already failing to meet consumption and/or cash requirements under the AMAR scenario were hit especially hard by an adult member contracting HIV. These households were more

likely to adopt grain amaranth as they had an increasing need to invest in livelihood strategies with a quick return on investment in terms of both food and cash.

7. Greater difficulty in meeting protein consumption requirements than calorie consumption requirements. As grain amaranth is particularly high in protein, but comparable to many grains in terms of calorie provision, it was more likely to be adopted by households who were struggling to meet minimum protein requirements.

Three of these categories (1, 3 and 6) are comparable to those outlined for households that were most likely to be food insecure under the HIV+ scenarios. This highlights the overlap between grain amaranth production and food security, especially in the context of HIV – grain amaranth adoption is strongly linked to households that are food insecure and hit more severely by HIV infection of an adult member.

All households that adopted grain amaranth production for consumption also sold some surplus, while not every household that adopted grain amaranth production for sale also consumed grain amaranth. Although this might indicate that grain amaranth has greater potential to be adopted as a cash crop, it is important to note that households that consumed grain amaranth were the ones that sold the most. This finding was comparable to that under the AMAR scenario, and indicates the need to promote both consumption and sale of grain amaranth.

The timing of adoption of grain amaranth production was distinctly different under the HIV+ scenarios compared with the AMAR scenario. Grain amaranth production was adopted as a livelihood strategy to a greater extent during times of increased acute stress, such as the phase of initial infection of an adult member with HIV and immediately following the death of an adult, than during the asymptomatic phase. This suggests that grain amaranth production has strong potential for helping households break out of the cycle of HIV and malnutrition (Semba & Tang, 1999), as it can be a key livelihood strategy to adopt in times of greatest stress on a household.

The infection of an adult member with HIV also had impacts upon other livelihood strategies adopted by households, not only upon grain amaranth adoption. Most agricultural production activities were reduced under the HIV+ scenarios, resulting in a reduction in both household consumption and sale of agricultural commodities. One exception to this trend was an increase in sorghum consumption by several households in both communities, especially those that had sufficient female labor (as sorghum was in the female domain) and yet had insufficient cash to invest in grain amaranth production. Another exception was an increase in the consumption of legumes by Mwatate households that had sufficient female labor, as these were crops that could provide a high intake of proteins and calories. The universal exception to the trend of reducing sales was that households increased their sales of livestock as a means of generating immediate income during times of acute stress. The only other exception was an increase in sugar cane sales by Amukura households that were neither land nor labor constrained, though the number of these households was small.

Overall, households in Amukura were more apt to adopt grain amaranth than Mwatate households. This was due to two major differences which were linked to the differing livelihood systems of the two communities. First, Amukura households struggled to meet minimum protein requirements than Mwatate households. This was due to the relative wealth of high protein legume options available to households in the Mwatate system in comparison to the few high protein options available to Amukura households. The infection of an adult member with HIV put all households under stress and as a result more households in Amukura were deficient in protein than in calories compared with Mwatate. Amukura households therefore adopted more grain amaranth,

especially production for consumption, as it was an attractive high protein crop that could help households to meet minimum protein requirements.

Secondly, Amukura households adopted more grain amaranth than Mwatate households because the number of potential seasons for production was higher in Amukura. Amukura households had the benefit of having three potential production seasons for grain amaranth compared to only two potential seasons in Mwatate. This was because the Amukura climate was wetter than Mwatate, allowing for a “mid-season” crop of grain amaranth in May-July, which was not possible in Mwatate due to a distinct dry season at that time. Amukura households therefore maximized the use of their available resources to take advantage of this additional production window for grain amaranth, and consequently produced more grain amaranth than Mwatate households.

The fundamental differences between HIV+ scenarios was that households 1) were more food and cash insecure under the HIV+ F scenario than under the HIV+ M scenario (households under both scenarios were more food and cash insecure than the AMAR scenario) and, 2) adopted more grain amaranth under the HIV+ F scenario than under either the HIV+ M scenario or AMAR scenario. This is a distinctly different finding from that of Thangata (2002) and Yamano and Jayne (2004), which indicated that households were more food and cash insecure when an adult male contracts HIV. The difference in the findings between this research and these previously published studies is due to these studies being conducted in different communities with different available livelihood activities, gender divisions of labor, and cultural practices surrounding agricultural production. For example, in Thangata’s study, the loss of male labor was

more devastating as the household economy was based on the production of tobacco for sale. Tobacco production was primarily the responsibility of adult males. One male labor was lost, tobacco could no longer be produced, and households no longer had sufficient cash to hire additional labor.

Meanwhile, in this research, households were more food insecure under the HIV+ F scenario because the reduction in available female labor critically undermined household food production. Households were more cash insecure under the HIV+ F scenario, as male labor had to switch away from a focus on cash generating activities towards household food production. Under the HIV+ M scenario, on the other hand, food production was not as severely reduced as adult female labor was still available, while cash generation was also not as severely reduced as households focused on selling surplus from food production activities. Grain amaranth adoption fell in line with the impacts of HIV upon overall household food and cash security. Therefore, there was more grain amaranth adoption under the HIV+ F scenario when households were generally under greater stress. In addition, households were more likely to continue to adopt grain amaranth following the death of an adult female, as households reprioritized their food production livelihood strategies to account for their change in composition. In contrast, grain amaranth production was rarely continued following the death of an adult male (under the HIV+ M scenario) as households could continue to adopt the same food production livelihood strategies.

Overall Conclusion

The potential adoption of grain amaranth production in HIV/AIDS-affected rural Kenyan communities depends upon initial acceptance of grain amaranth as a viable livelihood strategy option by households within a community. Following acceptance, the

potential adoption of grain amaranth production depends on both the livelihood system context of these households and the resource availability of diverse households. The most important livelihood system factors identified were the range of available protein sources and the number of seasons for possible production of grain amaranth. In terms of household resource availability, Table 8-1 presents the major specific factors identified by this study that affect the potential adoption of grain amaranth production in the context of HIV. It should be noted, however, that this table presents the two extremes of a spectrum of resource availabilities found in diverse households, and that households fall on a continuum of potential adoption of grain amaranth.

Table 8-1. Major factors influencing the potential adoption of grain amaranth production by diverse households within a rural Kenyan community affected by HIV/AIDS

Lower likelihood of adoption	Greater likelihood of adoption
Food secure	Food insecure
Insufficient calorie intake/No consumption deficiency	Insufficient protein intake
Low end cash and consumption requirements	High end cash and consumption requirements
Lack initial cash for investment	Available initial cash for investment
Lack male labor, plentiful female labor	Lack female labor, plentiful male labor
Female headed household	Male headed household
HIV+ adult male	HIV+ adult female
Low consumer/producer ratio	High consumer/producer ratio
Available land	Lack available land

Overall, grain amaranth has significant potential to improve both the food and cash security of rural, resource-limited Kenyan households affected by HIV/AIDS. However, grain amaranth does not have universal potential and is unlikely to be a crop adopted by every household, especially not when it is initially introduced into a community. There are clearly certain types of households, which have been outlined in this study, that are more apt to adopt grain amaranth than others. In addition, the impacts of HIV infection of an adult member are not uniform but diverse, and these impacts must be carefully

considered when considering the potential adoption of grain amaranth by diverse households within a community.

These conclusions need to be put into practice. The following section puts forward recommendations to help current and future grain amaranth promotion efforts. It is hoped that these recommendations can be of benefit not only to those promoting grain amaranth but also to communities in which grain amaranth is and will be introduced.

Recommendations

This research has highlighted that the potential adoption of grain amaranth is highly variable between rural Kenyan communities and also among households within these communities. However, some general patterns of potential adoption have been identified and these patterns are useful in instructing how this research can be applied in the field. The following recommendations provide possible ways forward for organizations and people involved in grain amaranth promotion efforts in order to increase both the efficiency and effectiveness of their work. Although the findings from this research were generated from Kenyan communities, it is likely that many of the ensuing recommendations could also be extended to other parts of rural East Africa. These recommendations have been split into two groups – first, recommendations for increasing the acceptance of grain amaranth in rural HIV/AIDS-affected communities, and secondly, recommendations for increasing the potential for adoption of grain amaranth in these communities.

Increasing Acceptance of Grain Amaranth

The following points are recommendations for increasing acceptance of grain amaranth both community-wide and by individual households in rural East African communities:

1. Increase community education and awareness of grain amaranth. This could be done in the following ways:
   - Increase support of partner organization and Ministry of Agriculture field days. These field days have the potential to reach a large audience and a wide range of people throughout a community. CDFs need to participate in these field days in order to be available to talk about grain amaranth with community members. Field days are more successful if active promotion of these events and mobilization of community members is done effectively. This requires the partner organizations to expend resources on mobilizing the community – a task that often seems laborious, but can have significant pay-offs.
   - Increase number of cooking demonstrations which involve the cooking of grain amaranth foods. These could occur in conjunction with field days or as independent events. These are important in getting people to taste grain amaranth. As taste was a major factor in influencing acceptance of grain amaranth, increasing the opportunities for people to taste grain amaranth is important. Furthermore, through these demonstrations, people can get ideas and instructions about how grain amaranth can be incorporated into various foods and into the traditional diet of rural households.
   - Increase household visits by the CDF. Individual visits to households who are known to be community leaders and/or innovators with the express purpose of discussing grain amaranth could spark greater enthusiasm about grain amaranth both within those households and among others that look up to innovative households for new initiatives.
2. Build capacity of CDFs and other community mobilizers with regards to grain amaranth.
   - CDFs and other community mobilizers must be supplied with adequate training about the potential benefits and constraints towards grain amaranth production. This could be done through the provision of grain amaranth workshops or short-term training opportunities by visiting scientists or development workers with expert knowledge on grain amaranth.
   - Increase the supply of educational materials about grain amaranth which can facilitate interest and build knowledge of CDFs and other community mobilizers, thus encouraging the spread of information and awareness about grain amaranth.
   - CDFs need to be regularly encouraged by their superiors with regards to promoting grain amaranth and producing and consuming it themselves in their community. This can lead to CDFs who are more confident in promoting grain amaranth and who have more knowledge about grain amaranth to impart to their community.
3. Develop deeper relationships between CDFs and their communities.
   - Dialogue between the CDF and community must be maintained for the grain amaranth program to be a success. As CDFs are the most important source of grain amaranth information in a community, trust and communication between the CDF and community members needs to be encouraged and built up to increase acceptability of grain amaranth.
   - Increase monitoring of CDFs in their performance on the grain amaranth promotion efforts. Those who are experiencing difficulties with their community need to be supported and encouraged by their organization, and ways to overcome these issues need to be found.
4. Develop and increase grain amaranth experimental initiatives within communities.
   - Small-scale experimentation by individual households should be encouraged. Small-scale experimentation is of low risk to households. Farmers who cultivate trial-size plots of

grain amaranth are able to evaluate first hand whether grain amaranth production is a livelihood strategy option they wish to pursue further.

- In addition to CDFs, neighbors and friends are important sources of trustworthy information for people in rural East African communities. The development of experimental initiatives with groups that are representative of a community can provide communities with visible evidence of the benefits of producing grain amaranth for both consumption and sale. Positive testimonies are powerful in East African society for generating community-wide acceptance of innovations such as the introduction of grain amaranth.
- In order to encourage further experimentation with grain amaranth, there needs to be an increase in supply of trial packets of grain amaranth seed that are of negligible cost to the experimenter. By supplying initial seed at low or no cost, households are encouraged to experiment with grain amaranth without risking significant cash investment.

Increasing Adoption of Grain Amaranth

The following points are recommendations for increasing adoption of grain amaranth both community-wide and by individual households in rural East African communities:

1. Promote grain amaranth as simultaneously both a potential food and cash crop livelihood strategy.
   - Grain amaranth should not be promoted as a livelihood strategy that is either a food or a cash crop, as this leads to the neglect of the potential of the market or the potential nutritional benefits of grain amaranth.
   - Findings from this study indicate that the households that sold the most grain amaranth were those that also consumed grain amaranth. This was because the consuming and selling of grain amaranth were activities that reinforced one another. Households that produced grain amaranth for consumption were ideally placed to also sell grain amaranth as 1) they had already overcome the initial constraint of high cash start-up costs and, 2) they could testify to the nutritional benefits of consuming grain amaranth, which generated self-confidence in their grain amaranth promotion efforts and provided legitimacy to their claims about grain amaranth when selling it in local markets.
2. Improve market accessibility through identification of potential market opportunities and linking communities with these opportunities.
   - Currently, potential supply of grain amaranth by resource-limited households outstrips the potential demand. There is an urgent need to identify market opportunities, whether for grain amaranth flour or for value-added products utilizing grain amaranth.
   - More households in both communities adopted grain amaranth production for sale than for consumption under all scenarios. While this does not undermine the need to promote grain amaranth on nutritional grounds, it does indicate the need to increasingly identify market opportunities for individual households and/or farmer cooperatives.
   - Linking households with market opportunities will increase awareness and spread of grain amaranth within and across communities.

3. Provide cash options to overcome the high initial cost of investing in grain amaranth production.
   - One potential option is seeking ways to offer households short-term, low-interest loans for the purpose of purchasing grain amaranth seed and fertilizer.
   - Another option is the provision of free or low-cost seed to households within a community as a one-time start-up deal. Seed could then be repaid after harvest. However, continual handouts of grain amaranth seed could serve to lead to dependence upon free/low-cost seed and undermine grain amaranth prices.
4. Develop incentives for increased grain amaranth production, especially during periods of least household stress.
   - Findings from this study indicated that grain amaranth production was highest during times of stress. Although these times of stress are common for HIV/AIDS-affected households in rural East African communities, there are also times when these households are relatively free from stress, such as when the C/P ratio is relatively low due to household compositions with few children and multiple adults. During times of reduced stress, households are more able to make livelihood strategy decisions to meet minimum consumption and cash requirements as well as even generate increased available discretionary cash. Grain amaranth production, however, was reduced once households had increased available discretionary cash as households switched to other strategies which had a higher return on investment. Incentives therefore need to be developed that encourage households to continue grain amaranth production once they have increased available cash. Incentives could include:
     - Development of value-added grain amaranth products for sale.
     - Development of exceptionally high grain-yielding varieties of amaranth.
     - Development of varieties of amaranth that are high yielding for grain and leaf and thus help to meet two parts of the essential diet.
     - Development of intercropping systems that incorporate grain amaranth, thus reducing labor, land and cash inputs.
5. Provision of information to community members on best practices for grain amaranth production.
   - In order to produce the highest yields from grain amaranth, certain best practices of production need to be followed. These practices have emerged from field studies and experimentation upon research farms, and need to be communicated effectively to community members. Important knowledge about grain amaranth that needs to be transferred includes information on planting, thinning, weeding, harvesting and post-harvest practices. Specific knowledge on optimum plant spacing and seed selection from plots for next year's supply are just two examples which were frequently mentioned by communities as lacking. This information can be provided through:
     - Community-based workshops or focus-groups
     - Pamphlets or brochures
     - Field days
     - CDF-farmer visits
6. Facilitate grain amaranth promotion activities among both men and women.
   - As grain amaranth is not a gender specific crop, it is important to make sure that promotion activities are not biased towards one particular gender. Women are important managers of the food production activities of a household, and are typically the ones that

make the choices about the constituents of a household meal. Meanwhile, men are important in making decisions about household cash generation. In addition, if grain amaranth is promoted among both genders, there will be an equality of information about grain amaranth and the facilitation of adoption by either or both genders.

7. Target particular types of households in initial grain amaranth promotion efforts.
   - This study identified certain types of households that are more apt to adopt grain amaranth. These should be primary targets of grain amaranth promotion efforts, as these households may then serve to be community leaders in grain amaranth production, and consequently community educators about grain amaranth. Such households to target initially include:
     - Households with sufficient male labor, but are constrained by available female labor, such as those that are male-headed, with one adult female and lacking in female youths. These households have sufficient available female labor to provide support to the men in the production of grain amaranth, without having too much available female labor which would lead a household to choose to maintain status quo in food production strategies.
     - Households that are land constrained. Grain amaranth offers these households the opportunity to generate a quick return of food and/or cash on a small area of land.
     - Households that are chronically food insecure. These households are often desperate, most in need of alternative strategies and most open to change due to their current unfortunate circumstances.
8. Maintain a culture of sensitivity regarding HIV/AIDS, taking care when promoting grain amaranth in a context of HIV
   - Although there is still a certain amount of stigma attached to HIV in some communities, in other communities this stigma is being reduced and people living with HIV are openly discussing their status. Even still, although grain amaranth has great nutritional promise for people living with HIV, promotion efforts should not solely focus on the HIV community. Such a focus could result in grain amaranth becoming associated with HIV. This could lead to two potential negative outcomes:
     - Those who do not have HIV do not want to produce grain amaranth as they do not want others to think that they have HIV.
     - People living with HIV also do not want to produce grain amaranth as they do not want other to know that they have HIV.
   - This study revealed that households with an HIV+ adult female are more apt to adopt grain amaranth production. In order to target households with an HIV+ adult female, women's groups that contain women who are open about their HIV status are a good place to start. An example of this is the AMPATH group that meets in Amukura – this would provide a good forum for promoting grain amaranth.
9. Increase inclusion of grain amaranth in food and nutrition packages targeted for times of greatest household stress
   - Lobby to include grain amaranth in food aid packages, such as those provided by international and local relief agencies
   - Include grain amaranth in nutrition training, such as through the AMPATH program in Western Kenya.

Policy Implications

Two important policy implications can be taken from this study. First, there is an urgent need for organizations and governments working in rural development to understand the complexity and diversity of livelihood systems and the decisions made within them in order to assess the potential adoption of an innovation and the impact of HIV on different communities and households. Within a particular livelihood system, there is a range of livelihood strategy options available to households with their own diversity of available resources. Essential to understanding the livelihood system is increased knowledge of household available resources and constraints, especially including increased gender awareness, as food security initiatives are most likely to succeed if there is a clearer understanding of ways to reach both men and women. Grain amaranth is one option that is being made available to households in rural East African communities as a potential way to improve food and cash security of these households. However, this study has also shown that grain amaranth production cannot be considered apart from the livelihood system in which it is being introduced.

Secondly and consequentially, a deeper understanding of rural livelihood systems calls for an increasingly holistic approach to development. Households and communities should no longer be viewed as independent of their surrounding economic, political, socio-cultural and natural environments. Instead, the interaction of households with these various environments needs to be understood if development efforts are to be successful in breaking the vicious cycles of poverty and malnutrition, and HIV and food insecurity. This study has shown that grain amaranth is one potential innovation that can be used to attempt to break these vicious cycles and thus demands further attention in research and development circles.

Further Research

Further research is necessary to address the diversity of household compositions and HIV scenarios that are found in sub-Saharan Africa, and their impacts on the potential adoption of grain amaranth production. Although the studied communities were representative of East African rural communities in many ways, it is also important to extend the analysis of potential adoption of grain amaranth production into other communities and cultures. In such analyses, it is crucial to consider the diversity of livelihood systems and the differences among various ethnic groups' responses to HIV infection.

Furthermore, although this study addressed sixteen households from each community that were representative of the diversity of household compositions and resource allocations in Amukura and Mwatate, there are an infinite number of different permutations of dynamic household compositions and available resources. Female-headed households with periodically returning adult males (for example, returning to their home village on weekends from the city) are a less common composition in the communities of study, but a type of household that is more frequently witnessed in other parts of rural East Africa. Also, an increasingly common household composition, especially in areas devastated by HIV/AIDS to a greater extent than Amukura or Mwatate, is one with no adult labor but grandparents in charge of young children. These types of household were not studied in this research, yet deserve more attention in future studies.

The impact of HIV upon potential adoption of grain amaranth was only considered in the context of one adult member contracting HIV. Further analysis could be undertaken to uncover the impact of multiple HIV+ household members – combinations

of adults, youths and children – upon grain amaranth adoption and other livelihood strategy decisions made. This is important as many HIV/AIDS-affected households have multiple members living with HIV, often at various stages of sickness.

This study also did not account for changes in market prices over time for various agricultural commodities. For example, further research could analyze the impact of a sudden change in the price of maize upon the livelihood strategies (particularly the potential adoption of grain amaranth) of diverse households. Such sensitivity analyses would help to outline how diverse households are affected by changes in the market, such as those witnessed as a result of the post-election violence in Kenya.

Grain amaranth is a heavy nitrogen feeder, and as households in both communities only solecropped grain amaranth, this raises questions as to the ecological sustainability of grain amaranth production. Further research into potential rotation systems that incorporate grain amaranth and possible intercropping options such as cultivating legumes and amaranth together is important to provide households with grain amaranth cultivation possibilities that are more likely to retain soil fertility over time.

Further research could also expand the ELP frame of reference through an integrated model of innovation acceptance and adoption. This study used an ELP that focused solely on the adoption of various activities by diverse households within a livelihood system. In order to make the ELP more realistic, additional factors could be added to simulate varying degrees of acceptance of grain amaranth by diverse households. However, this would also result in a far more complex ELP, which would consequently be more difficult to interpret and identify major constraints to grain amaranth production.

Academic research on grain amaranth is still unsubstantial, and many more assessments need to be conducted to expand the literature and global knowledge base on grain amaranth's role in human food systems. This study has provided an in-depth assessment to match its overall goal - to examine whether grain amaranth is a livelihood strategy option that could reasonably be expected to be adopted by diverse rural households that are constrained by poverty, malnutrition, and HIV/AIDS. This research has shown that grain amaranth has significant potential to be adopted in rural East African communities especially by certain types of household in specific contexts. It is hoped that the recommendations from this study will help guide those promoting grain amaranth and prove particularly beneficial to the rural poor.

APPENDIX

A. Topic Guides for Focus Groups and Sondeo Discussions

Topic Guide A

Research Question 1: What are the Current Livelihood Systems of the Two Communities (Amukura and Mwatate) and the Current Livelihood Strategies Adopted by Diverse Households within these Communities?

What activities take up your day?
What are the things you do on a regular basis, i.e. every day, every week, etc?
What is the total acreage of land you have available to your household? Owned? Rented?
Do you have a title deed to your land?
Is it registered in your name? Or someone else's? Or not registered?
How is the labor in your household organized? Who is responsible for what activities?
Who in the household helps with cropping activities? And who with the animals?
Do you ever get outside labor or help with livelihood activities?
What are your household's most important cash enterprises/ways to earn cash?
Do you have any source(s) of off-farm income?
What are the most important food crops for your household?
What are the most important cash crops for your household?
Do you have guaranteed prices for any crops? Do you have contracts for certain prices and certain quantities of products?
What are the current prices of grain amaranth; maize; cassava; other food and cash crops?
Are there certain times of year when prices are higher/lower for each of these crops?
What groups are you a member of? How do they impact your time and your activities? What benefits does that membership give you?

Topic Guide B

Research Question 2: What are the Social Attitudes towards Grain Amaranth in Amukura and Mwatate?

How did you find out about grain amaranth?
Have you ever eaten grain amaranth before? In what forms?
Did you like the taste? Would you choose to eat grain amaranth if it was an option?
What are the disadvantages/advantages of eating grain amaranth?
Is grain amaranth easy to prepare?
Have you ever grown grain amaranth before?
What are the disadvantages/advantages of cultivating grain amaranth?
How does it compare to other grains in terms of production?
Is *mchicha* considered a female or male crop? What about grain amaranth?

What would stop you from cultivating grain amaranth at your next opportunity?

Topic Guide C

Research Question 3: For Which Kinds of Households is Grain Amaranth Production a Feasible Livelihood Strategy Option in these Communities?

How would grain amaranth production fit into the agricultural seasonal calendar in this community?
Are there certain production tasks for grain amaranth that are gender-specific?
Would grain amaranth be grown primarily as a food or as a cash crop?
What are the main constraints that would prevent your household from grain amaranth production?

Topic Guide D

Research Question 4: What is the Impact of HIV/AIDS upon the Potential Adoption of Grain Amaranth as a Livelihood Strategy by Diverse Households in these Communities?

What happens when someone in a household gets sick? Does it matter who gets sick?
How do other households in the community respond when someone in another household gets sick?
What happens if someone in a household gets sick due to HIV or AIDS?
What would a household do in response to someone in their household getting sick due to HIV/AIDS? Does it matter who contracts HIV – would their response differ?
How is the gender and/or age division of tasks affected? Are there tasks that will not be taken up by the other gender or other age group?
What about if someone hears of another member of the community getting sick due to HIV/AIDS – what is their response as a household then? Does it matter who contracts HIV – would their response differ?
Are these responses any different from when someone gets sick with another illness?
From what you know about grain amaranth, would a household be more likely to cultivate grain amaranth if someone in their household gets sick due to HIV/AIDS? Why?

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BIOGRAPHICAL SKETCH

Thomas Brooke Gill was born in 1980 in Margate, England. Growing up with his parents and two sisters in close proximity to mainland Europe, Tom developed an interest in the wider world and completed a Bachelor of Arts in geography from Emmanuel College at the University of Cambridge. Tom then worked as a missionary in northern Uganda, where he learnt firsthand the rural poor's dependence upon agriculture for daily survival. Upon returning to England, he completed a Master of Science in tropical agricultural development from the University of Reading. Following his studies, Tom worked for Educational Concerns for Hunger Organization (ECHO) in North Fort Myers, Florida where he learnt practical skills for tropical agriculture and put them into practice during extended time in Uganda. Tom left ECHO to pursue his PhD at the University of Florida in interdisciplinary ecology with a concentration in farming systems. Tom now works as Africa coordinator in the International Programs Office of the College of Agricultural Sciences at the Pennsylvania State University. Tom lives in State College, Pennsylvania, with his wife, Betsy and their daughter, Melissa.