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A farming System Analysis on the slope of Mount Kenya

A study of how water resources and land use are affected by climate variability in two areas in Embu District, Kenya

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Title: A Farming System Analysis on the slope of Mount Kenya - A study of how water resources and land use are affected by climate variability in two focal areas in Embu District, Kenya

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Front-page picture: Joyce, Tea farmer in Kithunguriri, Embu District, Kenya. Photo Ida Enjebo

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We were part of a research team with Alba Saray Pérez-Terán (ICRAF Vietnam), John Kennedy Thotho Njenga (B.Sc. student at Jomo Kenyatta University of Agriculture and Technology, JKUAT) and Burnice Karimi (B.Sc. Environmental Sciences). The field work was supervised by Dr. John Mwangi Gathenya and Dr. Peter Mwangi Njoroge from JKUAT and Dr. Delia Catacutan from ICRAF. We are very grateful for your engagement, knowledge and advice during our work in Kenya. In addition, we thank the botanical experts John and Josphat from JKUAT and the ICRAF driver Benjamin. We also want to thank Marc Dumas-Johansen (ICRAF Vietnam) for your help during the preparation of this study and Catherine Kimengu (ICRAF Nairobi) for all your assistance with practical arrangements.

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Abstract

This study took place in the Kapingazi River catchment in the Eastern Province, Embu District, Kenya. The main objective was to assess the vulnerability towards climate variability of smallholder farmers by using a set of Participatory Rural Appraisal (PRA) tools. The particular focus was on issues related to water resources and the strategies farmers have developed to adapt to and cope with climate variability, in particular related to rainfall. The Kapingazi River catchment is a highland region on the southeast slope of Mount Kenya. This region has bimodal rainfall with one long and one short period of rain.

The Kapingazi River catchment is home to a range of water resource issues caused by several factors such as destruction of the catchment area due to deforestation, overgrazing and poor cultivation methods, water conflicts due to water shortage and misuse of water, erosion of river banks due to land scarcity, and planting of eucalyptus trees on the river banks. The Kapingazi River contributes to the Tana River with hydropower plants that generate a large part of Kenya's electricity production.

The fieldwork consisted of interviews and the data were collected in three steps. Firstly, focus group discussions were held with community representatives. Secondly, based on the results from the group discussion, participants for in-depth interviews were selected and interviewed. Thirdly, a questionnaire was designed and used to collect quantitative data.

Results from the study show that the vulnerability towards climate variability of the farmers varies between as well as within the different parts of the catchment. The difference in vulnerability showed, during the in-depth interviews, also to be related to the farmers' wealth. This difference shows that a poor farmer experiences lack of drinking water and hunger during dry periods, whilst a rich farmer experiences loss of income and shortage of irrigation water.

Content

1 Introduction

The tropical region is, like the rest of the world, affected by climate change. Impacts of the global warming have been reported as extended drought in some regions and extreme floods in others. Sub-Saharan Africa is a region severely hit by climate change and climate variability (Paeth et al., 2009). Kenya, situated in East Africa, is one of many countries in the tropics where these issues have profound effect on local people's livelihood. Agriculture is the main occupation and source of income for the majority of the Kenyan population (Nationalencyklopedin, 2011). Due to the vast differences in climate, only 15 % of Kenya's total area (580 000 km^2) receives sufficient annual precipitation to support productive cultivation (Frame, 2009).

The project site, the Kapingazi River catchment, is located in Embu District, Eastern Province, on the southeast slope of Mount Kenya. This region has bimodal rainfall with one longer and one short period of rain. Most of the rain that falls on Mount Kenya originates from the Indian Ocean and falls as orographic precipitation on the southeast slope (BBC Weather, 2010). The Kapingazi River catchment is home to a range of water resource issues caused by several factors such as destruction of the catchment area due to deforestation, overgrazing and poor cultivation methods, water conflicts due to water shortage and misuse of water, erosion of river banks due to land scarcity, and planting of eucalyptus trees on the river banks (WRUA and WRMA, 2009). The Kapingazi River contributes to the Tana River, with hydropower plants that generate 70 % of Kenya's electricity production. The flow in the Kapingazi River varies considerably throughout the year, during the drought periods the flow is very low and after the start of the rainy periods the flow is high, which causes problems such as erosion. As a result of the increased runoff, high quantities of eroded particles are transported into the river, which becomes heavily loaded by sediments. This affects the hydropower plants when the capacity of turbines is reduced and the turbines require more maintenance (van Noordwijk et al., 2011).

Understanding the difficulties local farmers face regarding access to water resources for farming as well as the selection of suitable species for different landscape units in order to reduce water shortage is considered important in the context of climate variability and changes. This knowledge will help to define suitable options to improve livelihoods for local farmers. Using different Participatory Rural Appraisal (PRA) tools[1], together with climate variability analysis, is assumed to be suitable tools for assessing impacts of climate on land use, particularly on the extent of high water-consuming plants such as coffee and eucalyptus. If these two species are planted together in one landscape unit, water may be depleted, causing water-resource conditions to change. Eucalyptus is planted widely by smallholders in East Kenya since it is an important cash crop for local farmers. The fast growth of eucalyptus results in a high accumulation of biomass, which makes it valuable on the carbon-trade market, but at the same time it also uses large water amounts (Muthuri et al., 2009). As a majority of farmers are subsistence farmers, the access to water resources is of outmost importance for maintaining their livelihoods. All these factors may be increased due to climate change and climate variability.

A set of PRA tools were compiled to target both spatial and temporal analysis of land use at three levels: plot, farm and landscape. Tools such as transect walks, timelines and participatory maps

[1] PRA is a research methodology with tools that are designed to target rural knowledge in a participatory way. Semi-structured activities are conducted by a multi-disciplinary team.

(Chambers, 1994) will give a good understanding of farmers' knowledge and perceptions of their local area. A similar set of PRA tools has proven to be effective in a previous study of farmers' climate-change-adaptation strategies in Vietnam (van Noordwijk et al., 2011).

1.1 Objectives and hypotheses

The main objective of this study is to assess the vulnerability towards climate variability of smallholder farmers in the Kapingazi River catchment in Embu District, Kenya, through using a set of participatory research methods (PRA-tools) including climate variability analysis. The particular focus will be on issues related to water resources and the strategies farmers have developed to adapt to and cope with rainfall variability.

The hypotheses in this project are:

- Land use in the upstream area will affect the available amount of water downstream. Therefore "the right trees in the right places" in a landscape is important when dealing with water issues in the catchment.
- Adaptation strategies will vary due to water availability, markets, infrastructure and climate conditions.
- The set of PRA tools will allow assessment of coping strategies and internal/external factors controlling the vulnerability of available water resources as well as activities dependent on water resources in Embu, Kenya.

1.1.1 Research questions

- How vulnerable are farmers in the Kapingazi catchment towards climate variability across the catchment?
- What are the most typical constraints local farmers will face?
- How do farmers adapt to water scarcity?

  On-farm:
  - Do farmers move towards livestock, trees or crops as an adaptation strategy?
  - Do farmers move towards intensifying or diversifying their farms?
  - What crops are resistant to climate variability according to local farmers?
  - To what extent is irrigation used and what is the water source?
  - What types of water and soil conservation do farmers practice?

  Off-farm:
  - What off-farm activities do farmers engage in?
  - Do farmers engage in more off-farm activities during dry periods?
  - What role do extension programs and social networks play when adapting to climate variability?

2 Background and Theory

2.1 PRA-tools

The Participatory Rural Appraisal (PRA) was developed by Robert Chambers and Gordon Conway in the 1960's with the purpose of redirecting the focus of research in rural areas (FAO, 1999). PRA is a method where the members of the community actively participate in identifying problems in the community giving the research their perspective. The PRA-tools have been combined into different toolsets, e.g. Participatory Landscape Analysis (PaLA) and Participatory Analysis of Poverty, Livelihoods and Environment Dynamics (PAPOLD). The toolset PaLA was designed to capture local knowledge on both temporal and spatial scale (Hoang, s.a.). The combination of tools in PAPOLD was developed to address local specific issues related to poverty, livelihood and environment as well as the inter-linkages between those (Hoang & Phan, s.a.).

2.2 Farming System Analysis

The farm system is defined on an individual farm level. When characterising a farm the main aspects taken into account are inputs, processes on the farm and outputs. The flow of resources through the farm as well as their interactions in the farm is considered during the analysis. To enable analysis of several farm systems simultaneously, individual systems with similar resource base, enterprise patterns and household livelihoods are grouped into farming systems. Another important ground for this classification is the common difficulties the farms face and therefore similar development strategies can be applied. The farming system approach has been used since the 1970's. The development has moved towards a more participatory approach using the indigenous knowledge, experimentation and monitoring (Dixon et al., 2001).

Figure 1 illustrates the interaction between production and consumption decisions. In addition to the factors shown in the figure there are external factors including institutions, policies, markets, public goods as well as climate influence. These parameters influence the decisions made at farm level and consequently the production outputs. The production decisions are determined by internal resources; social, physical, natural, financial and human, and the external inputs. Following the production a decision of the use of the products has to be made (Dixon et al., 2001).

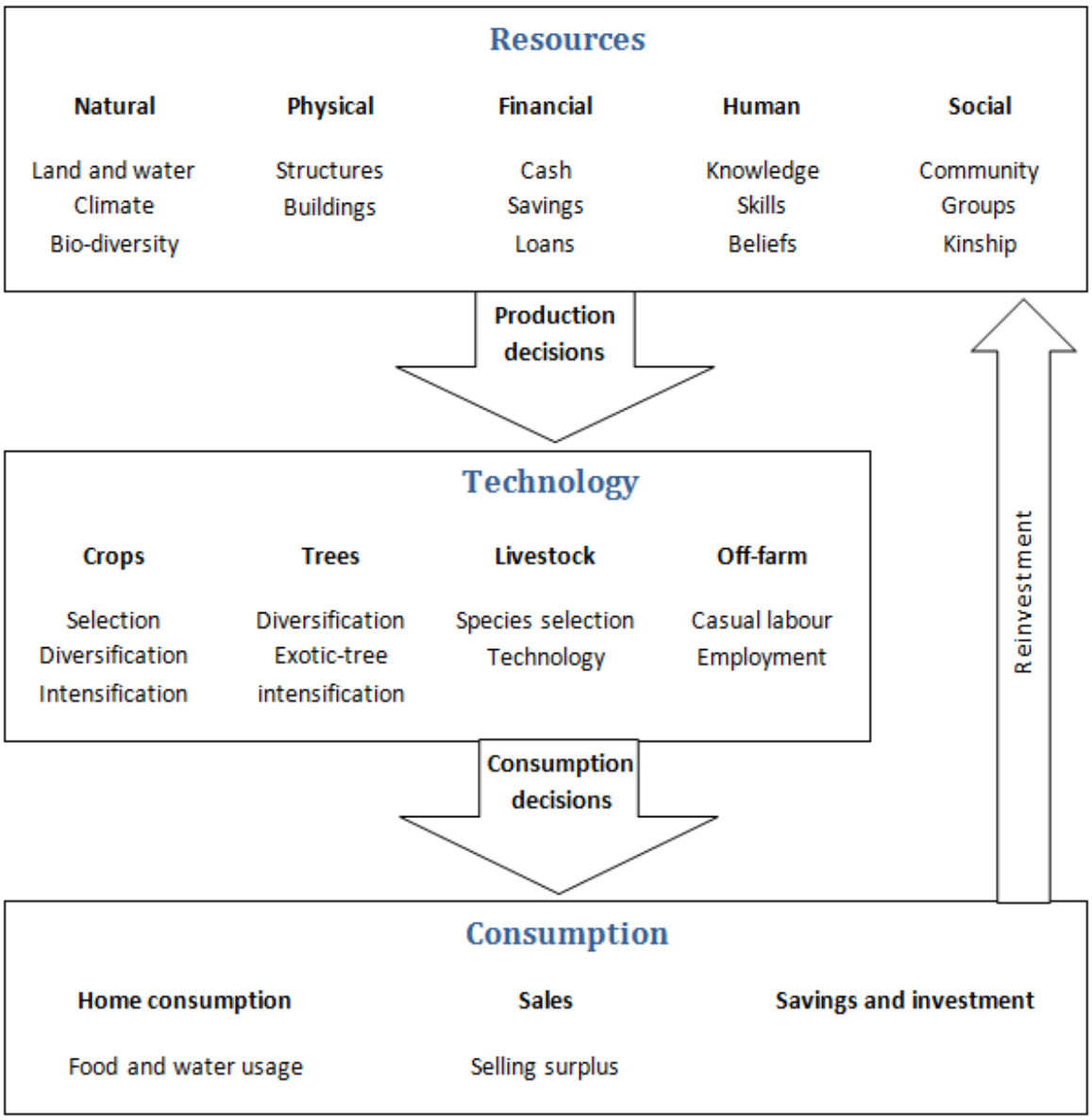

Figure 1. Schematic illustration of farming systems (Dixon et al., 2001).

The farming system approach enables multi-disciplinary analyses of farm production. The integration of socio-economic and biophysical parameters with the production is what makes this approach strong when analysing (Dixon et al., 2001).

2.3 Farming Systems in Central Kenya

FAO has identified 15 farming systems in Sub-Saharan Africa. The central parts of Kenya are classified as a mixed maize farming system according to FAO. The main crop grown in this system is maize and depending on wealth different cash crops such as coffee, tobacco, groundnuts and sunflower are used. In general the main issue in the mixed maize system is population density and as a result farm size rather than drought (Dixon et al., 2001).

2.4 Projects and Schemes in the Kapingazi Catchment

2.4.1 PRESA

The Kapingazi catchment is one of the sites of the World Agroforestry Centre (ICRAF) project named 'Pro-Poor Rewards for Environmental Services in Africa' (PRESA) (PRESA, 2010). The main objective of PRESA is rewarding smallholder farmers and residents who live in the highlands of East and West Africa for environmental services (PRESA, 2010). ICRAF works towards improving the living conditions for the smallholder farmers and towards improving the environment. ICRAF's research on the roles trees play in agricultural landscapes aims to advance policies and practices that are advantageous to these purposes (PRESA, 2010).

2.4.2 MKEPP

The Kenyan government considers that issues regarding soil and water conservation are important. Poverty is an important reason for poor farm management which leads to degradation of catchments. Lack of conservation strategies in upstream regions affect the downstream negatively, e.g. sediments transported to hydropower reservoirs. The government initiated the Mount Kenya East Pilot Project for natural resource management (MKEPP) to manage these issues in the Tana River catchment. MKEPP addresses these issues with five different approaches: water resources management, rural livelihoods, environmental conservation, community empowerment and project management and coordination. The overall goal of MKEPP is to reduce poverty by cooperating with several organizations and projects e.g. PRESA (MKEPP, s.a.).

2.4.3 Rainforest Alliance

An important stakeholder in the upper part of the Kapingazi catchment is an eco-labelled tea factory. The factory is certified by Rainforest Alliance who works with implementing sustainable agriculture on the smallholder farms, e.g. by promoting different soil and water conservation strategies as well as planting of trees. With the certification the factory provides training, workshops and diagnostic visits (Rainforest Alliance, 2011).

The work is carried out according to the ten principles of the Sustainable Agriculture Network standards: social and environmental management system, ecosystem conservation, wildlife protection, water conservation, fair treatment and good working conditions for workers, occupational health and safety, community relations, integrated crop management, soil management and conservation and integrated waste management (Sustainable Agriculture Network, 2010).

2.4.4 WRUA/WRMA

Water Resource Users Association (WRUA) is a community based organisation working with issues related to the management of water resources. Water Resource Management Authority (WRMA) is the corresponding government based organisation. The two organisations have together developed a sub-catchment management plan for the Kapingazi catchment (WRUA and WRMA, 2009).

3 Methodology

3.1 The Study Site

The Kapingazi River catchment is located in the Eastern Province, Embu District on the slope of Mount Kenya (Figure 2). The catchment has a population of approximately 40 000 (MKEPP, 2009) and covers an area of 61.23 km^2, it is 27 km long and is situated at altitudes between 1230 m to 2100 m above sea level (MKEPP, 2009). The soil type is fertile and very erodible, dark reddish brown. Closest to the mountain forest, at the top of the catchment, an area of mountain slope soil is found. This area is too steep to cultivate most agricultural crops. In the lowest part of the catchment, where Kapingazi joins the river Rupingazi, the soils are plateau soils with low to moderate fertility (Jaetzold et al., 2006).The average annual rainfall varies from 1200 mm to 1800 mm on the lower and upper part of the catchment area, respectively (Esther, 2009).The temperatures varies from 15^0C to 28^0C throughout the year (WRUA and WRMA, 2009).

The Kapingazi catchment was divided into five Focal Development Areas (FDAs) by the MKEPP project in 2002, of which the two selected for the study are shown in Figure 2. These boundaries were created solely for the MKEPP project for watershed management purposes and are not administrative.

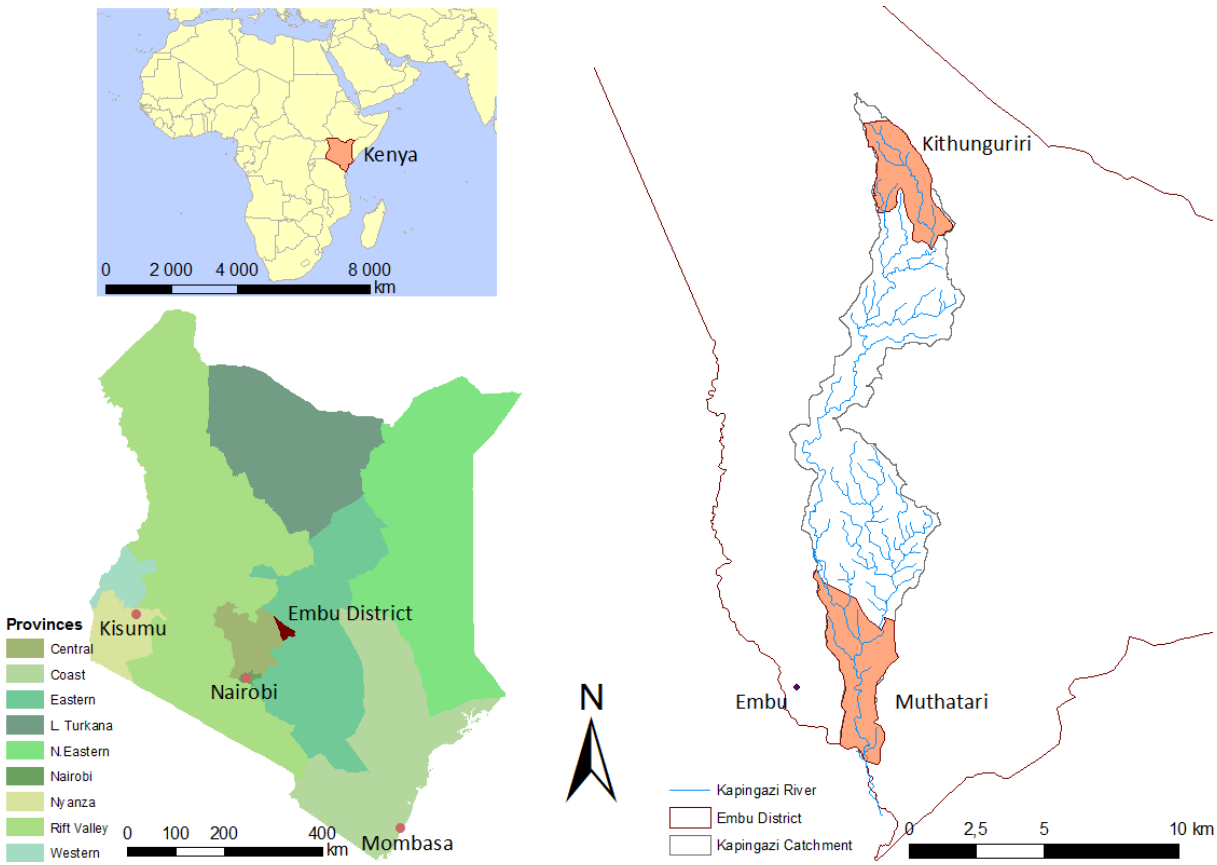

Figure 2. Study-area location. The two selected Focal Development Areas (FDAs), Muthatari and Kithunguriri, are marked in red on the map to the right.

3.1.1 Agro-ecological zones

Throughout the area there is subsistence farming with cultivation of maize and beans. In the catchment four agro-ecological zones can be found (Jaetzold et al., 2006). Below they are described, starting from the top, following the river downstream:

1. The lower highland zone 1, LH1, is a tea and dairy zone characterized by steep slopes and valleys. This area has two cropping seasons, one very long and one medium long. There are cold temperatures from July till September and the area gives good yield potential for high-quality tea.
2. The upper midland zone 1, UM1, is a zone suitable for coffee and tea production. This area has one full long and one medium cropping season with intermediate rains. This zone is a transition between the tea and coffee growing areas.
3. The upper midland zone 2, UM2, is the main coffee zone with one medium and one medium to short cropping season. Apart from coffee this area gives good yields of fruits, e.g. passion fruit, bananas, pawpaw and avocado.
4. The upper midland zone 3, UM3, is a marginal coffee zone with one medium to short and one short cropping season. This zone gives fairly good yields of coffee but is more suitable for maize and sunflower.

3.2 Site selection

The criteria for selecting the study area were that it (i) should be representative for interlinks between upstream and downstream villages, (ii) must have experienced climate variability and (iii) have farmers with knowledge and long experience of cultivation in the area and plots located in different parts of the landscape. A pre-selection of two FDAs was done based on previous household surveys by PRESA, GIS data from Mount Kenya East Pilot Project (MKEPP) and discussions with scientists from World Agroforestry Centre (ICRAF). The two pre-selected FDAs are located along the main river and differ on the following criteria: access to forest, access to urban centres, elevation, agro-eco zone and water sources for agricultural activities.

After visiting the Kapingazi catchment and discussing with local community representatives from WRUA and government officials from MKEPP, two final FDAs were chosen, Kithunguriri, closest to the forest, and Muthatari, close to Embu town. Table 1 shows a description of the study areas. During the discussion with local community representatives the PRA tool problem-solution tree was used to obtain an understanding of the problems and causes in the study area related to drought.

Table 1. Description of the selected study areas

	Kithunguriri	Muthatari
Location	Upper-most part of the catchment, closest to the Mt Kenya forest	Lower-most part of the catchment, nearby Embu town
Elevation	1800 - 2000 m	1250 - 1500 m
AEZ	LH 1	UM 2-3
Main farming activities	Tea and dairy farming	Coffee and horticulture farming
Agricultural Water	Rain fed	Rain fed + small area with irrigation scheme.
Rainfall	1600 - 1800 mm/year	1000 - 1200 mm/year
Common local groups	WRUA, milk cooperative, common-interest groups (CIGs) for goats, poultry, bananas, bees, etc.	

3.3 Study method

The research team was divided into two teams. During the Focus Group Discussions (FGDs) both teams worked together as well as during the first in-depth interview. The remaining time each team was joined by a botanical expert (technician from JKUAT) and the two teams carried out interviews simultaneously. The two teams worked in both FDAs. The two authors were members of one of these teams and participated in the planning, data collection and evaluation. Apart from the methods (PRA tools) presented below, the teams conducted additional studies (using additional PRA tools) from which the results will be used in a comparative study between sites in Kenya and Vietnam.

3.3.1 Preparations

Prior to arrival in Kenya a literature review of previous studies in the area together with GIS analysis of data collected by PRESA was done.

The research method was developed by the team while brainstorming on PRA-tools from the Participatory Landscape Analysis and Participatory Analysis of Poverty Livelihoods and Environment Dynamics toolsets (Hoang & Phan, s.a.), (Hoang, s.a.). The chosen tools were for landscape (FDA) level: FDA sketch, FDA timeline, wealth ranking and stage of progress. For farm level the following tools were used: farm sketch, problem-solution tree, seasonal calendar, transect walk and field (plot) timeline. Based on the analytical framework a checklist containing target, objectives, assumptions and sought information for each tool was developed.

3.3.2 Focus group discussion

In order to obtain information on the FDAs on landscape level a Focus Group Discussion (FGD) was held with FDA committee members, one FGD in Kithunguriri and one in Muthatari. The expected output of the FGD was to obtain a base on which to select households for the in-depth interviews. The first tool used was FDA sketch with the aim to get information about the community and water resources as well as strong and weak points in the landscape. The purpose of this tool is not to get a map-like sketch of the area but to get an understanding for how the participants perceive the area. The full checklist can be seen in Appendix 1. The sketch was drawn on a flipchart by the facilitators while the participants discussed and explained, shown in Figure 3.

Figure 3. Muthatari FDA committee members participating in FDA sketch exercise

Following the sketch, a FDA timeline was created to document the history of the community, introduction of new species and activities of organizations/projects in the area. Especially focussing on events related to extreme weather conditions such as droughts and floods. The participating committee members were discussing facilitated by a member of the research team.

In order to obtain information and indicators of wealth in the FDA the PRA-tools wealth ranking and stages of progress were used. This set of tools was used to find out how the participants perceive wealth in their FDAs both by characterising wealth groups and distinguishing the line between them. The participants named and defined the different wealth groups and added indicators for each group. One assumption made by the team was that adaption (long term) and coping (short term) strategies would differ depending on wealth of the household. The indicators from these tools were therefore used as selection criteria for the in-depth interviews with key informants.

3.3.3 In-depth interviews

In-depth interviews at farm level were held in 6-7 households per FDA. The households were selected with help from the FDA chairman based on the information from the FGD; two households in each wealth group (lower, middle-lower and middle class in Appendix 2 and Appendix 3). The PRA tools were chosen in order to target the adaption and coping strategies and to get the reasons behind by using open ended questions. Throughout the interviews, one member of the team acted as facilitator while the others recorded and took notes and photos. The information gathered during the in-depth interviews was used when designing the questionnaires for the quantitative interviews. The first tool used was the farm sketch where the interviewee explained and drew the different parts of the farm, indicating current land use and size, water sources for domestic and agricultural use, structures for livestock and number of animals and homestead structure and size, shown in Figure 4. The full checklist can be seen in Appendix 4.

Figure 4. Farm sketch exercise with Wilson Kariuki, Kithunguriri

Secondly, a seasonal calendar showing the activities on the farm during a normal year was drawn on a flipchart by the facilitator, starting by asking the interviewee to mark the start and end of rainy

periods. Using the information from the farm sketch, the facilitator asked about the timing of planting, weeding and harvesting seasons for the different crops and trees on the farm. In addition, questions about sources and periods of income were asked and marked on the calendar.

Thirdly a problem-solution tree was created with the topic drought, with the target of finding problems caused by absence of and delayed rains and the strategies to adapt and cope with these problems.

The final two PRA-tools, the transect walk and the plot time line were combined to see the current land uses and how they have evolved over time, shown in Figure 5. During the transect walk the GPS coordinates of the farm's corners, different field plots, homestead, hotspot and filter areas were recorded. In addition, a botanical expert took notes of all species found on the farm; this information will be used in the parallel botanical study.

Figure 5. Transect walk in Charles Mwangi's farm in Muthatari

3.3.4 Quantitative interviews

To obtain quantitative data a farming-system analysis survey was held using formal interviews. Approximately 4% of the total population in the FDA was interviewed, 40 households per FDA. To avoid bias the households were selected using a geographical sampling method. Five transects evenly spread through the FDA, perpendicular to the river, were created using ArcGIS. Along these, 50 points were marked with equal distances in between, shown in Figure 6.

A questionnaire was designed using the information from the in-depth interviews aiming to capture the wealth of the household, size of the farm, crop species and varieties of some of the key crops, tree species and numbers, livestock species, off-farm activities and the interviewees' perception of climate variability and how they address these issues. The full questionnaire can be found in Appendix 5.

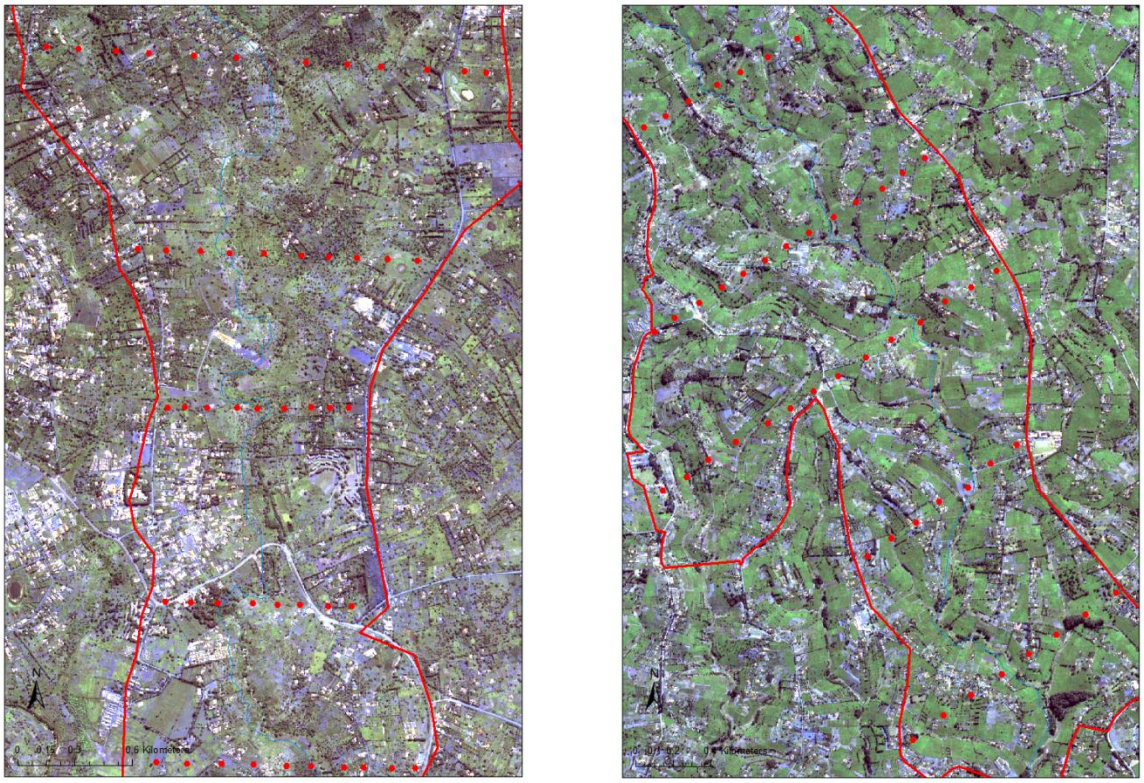

Figure 6. The solid red lines mark the boundaries of the FDAs Muthatari (left) and Kithunguriri (right). Farms where data collection was carried out were selected along the dotted transect lines.

4 Results and Discussion

4.1 Focus Group Discussion

In this section the results from the PRA tools that were used in this study are presented. The participants in the FGD were all members of the FDA committee selected with help from the FDA chairman. The key informants were selected from the following criteria: gender and place of residence. The aim was to have a group that was representative of the area. In this exercise wealth was not a selection criterion. This bias has been accounted for during the analysis process since the results are the opinions of five people. Due to lack of time for preparations, in the FGD in Muthatari four men and only one woman participated. In the Kithunguriri three men and two women participated.

4.1.1 FDA sketch

The results from this tool, shown in Figure 7, illustrate an overview of the participants' perception of the FDAs. The sketch of Muthatari shows institutions that the participants find important and infrastructure and that the less fertile agricultural land are on the steep slopes along the river. Another important result is the access to an irrigation-water system on the west side of the river. This affected the selection of farmers for the in-depth interviews.

The sketch of Kithunguriri shows that the access to electricity is limited to the area along the main road. Electricity is not an indicator of wealth in this FDA and can therefore not be used as a selection criterion for the in-depth interviews. Tea-buying centres are scattered throughout the FDA, a sample of which are shown with T in the sketch. There are also a number of dairy markets, marked with D in the sketch. The pale green lines indicate that the yield and the quality of the tea increase at higher altitudes. In general, the steep slopes along the river are covered with tea bushes; the erosion-prone areas are hence concentrated to areas with bare soil.

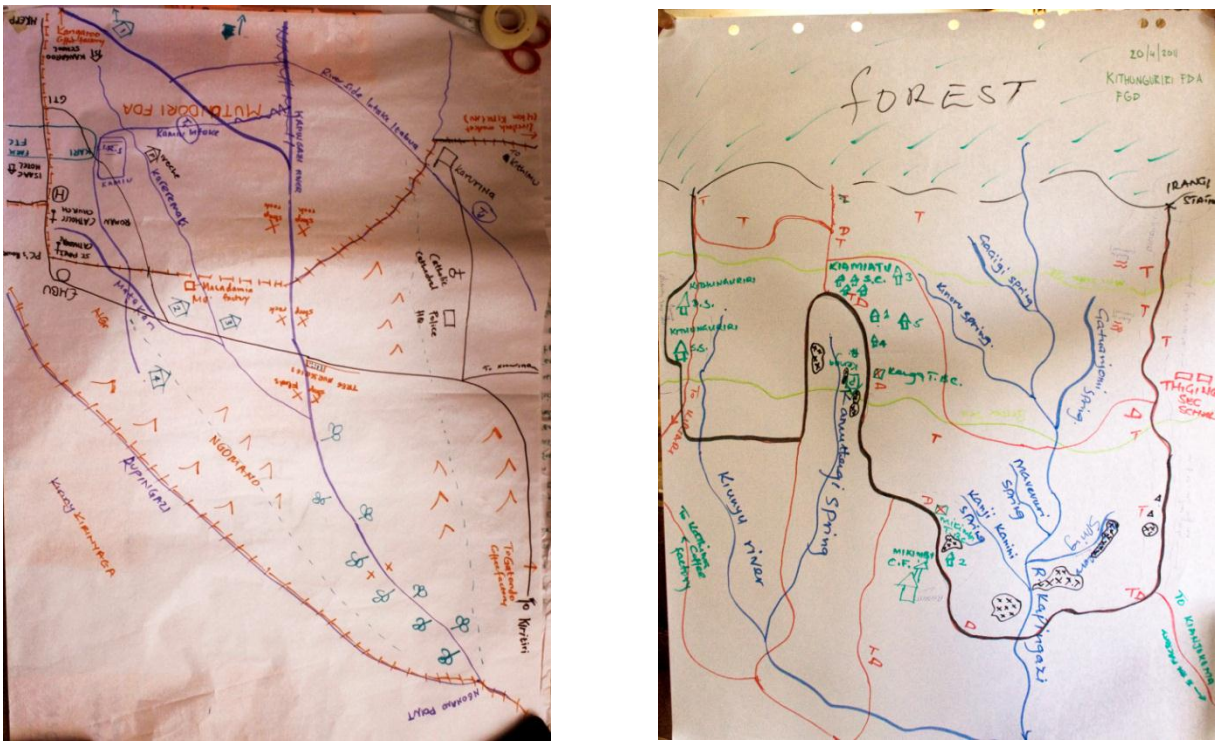

Figure 7. FDA sketch of Muthatari (left) and Kithunguriri (right)

There are differences between the west and east side of the river. Due to this fact, the team formulated the criterion that the in-depth interview households should be from both sides of the river.

The participants marked the location of their residences with a green house with a number and it is apparent that the whole FDAs were not geographically represented. In addition to the conclusions drawn from the tool, it is effective as a starting point for further discussions.

4.1.2 Timeline

The main topic of the timeline exercise was historical events related to drought. Most of the events were brought up in both FDAs, for instance a drought in 1984, large amount of rain in 1997 and the current drought in 2011. In general more weather incidents were mentioned in Muthatari, e.g. a major drought in 2000. During that year only 500 mm of rain fell in the area, which is considerably less than average. Both FGDs mentioned mobile phones and the positive effects they have had on the community, especially in times of crises. They can be used to send money to friends and family as well as to find out where food can be bought at the best prices

4.1.3 Wealth Ranking and Stages of Progress

The results from Muthatari, found in Appendix 2 and Appendix 6, describe the extremes. They all categorised themselves as middle class, consequently risking prejudice when characterising the other wealth groups. When talking about an upper-class person they referred to the richest person in the FDA, therefore the upper-class was not included when selecting participants for the in-depth interviews in Muthatari. Instead, the team chose to divide the middle-class category into a lower and an upper sub category based on the stages of progress. The team decided to use concrete selection criteria like farm size, family size, livestock and construction material.

The participants in Kithunguriri chose to use less extreme criteria to describe the categories. The categories used in the results, found in Appendix 3 and Appendix 7, were poor person, normal person and rich person. An important factor when improving one's living standard was considered to be the education of the children, an educated child can help the whole family to rise from poverty. The team decided to use the same wealth indicators as in Muthatari as criteria but with different intervals.

4.1.4 Summary – Focus Group Discussions

When conducting the tools, different assumptions were made by the team:

- Sketch
    - Wealth and vulnerable areas are related
    - Strategies and vulnerable areas are related
- Wealth ranking and stages of progress
    - Households with different income will have different strategies
    - The households' assets, such as land size, quality of soils and access to water will affect their strategies
    - The level of education will affect the strategies

The assumptions contain factors that are discussed in these three tools. To confirm these, the tools had to be analysed together. Some of the assumptions were confirmed at this stage, e.g. that wealth

and the location of the farm are related. When it comes to level of education, this showed to be an important strategy in itself in Kithunguriri.

The selection of participants for the FGDs and the in-depth interviews contributes to uncertainty of the objectiveness. Initially with the selection by the chairman of the FGD participants, this gives bias in the results. The criteria for selecting in-depth interviewees are based on the FGD results and again, the FDA chairman helped with picking out suitable households.

4.2 In-Depth Interviews

The methodology for the in-depth interviews was decided on by the team through brain storming. The objective of the interviews was to find the reasons for different adapting and coping strategies.

4.2.1 Farm Sketch

The farm sketch was used as an ice breaker where the farmers could talk freely about their families, farming practices and what could be found on their farms. No farm sketch looks exactly the same but the differences between the farms were smaller in Kithunguriri than in Muthatari. This is due to the fact that tea is the dominant cash crop in Kithunguriri, whereas in Muthatari the diversity in cash crops is larger. Examples of cash crops in Muthatari found during the in-depth interviews were coffee, nuts and fruits. Figure 8 shows a farm sketch from a “rich person’s” household in Kithunguriri. The farm sketch is a basis for the selection of the transect.

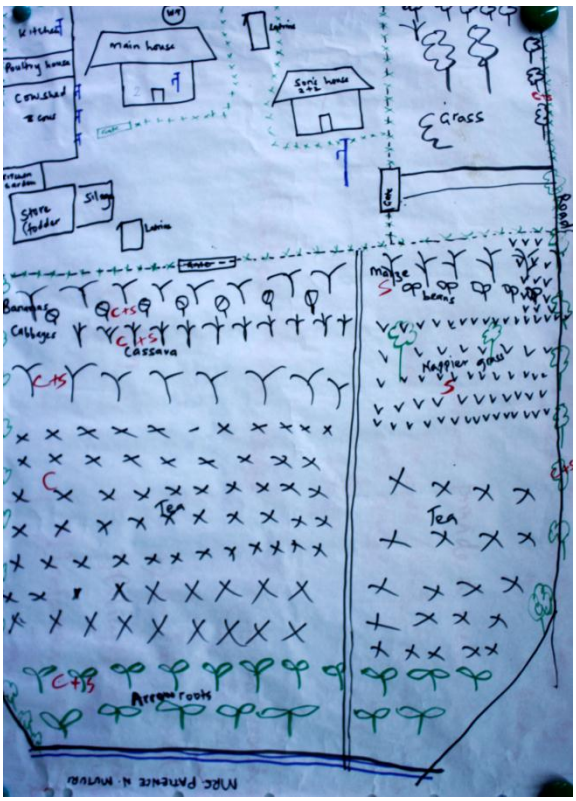

Figure 8. Farm Sketch from Patience N. Muturi’s farm in Kithunguriri

4.2.2 Seasonal Calendar

The seasonal calendar gives an estimation of how the interviewee perceives the seasons and their variations. As a general result, the interviewed farmers have experienced changes in the seasons, in particular that the starting time of the rainy seasons has become less predictable.

The results from the seasonal calendars in Muthatari, found in Appendix 8, show two clear planting seasons, the first goes from March to August and the second starts in October and ends in December or January. The planting roughly coincides with the start of the rainy seasons. The season for the long rains usually starts in mid-March and continues through May.

In Kithunguriri both rainy seasons are longer than in Muthatari. The long rains start at the same time but continue through June. In general the climate is wetter and colder in Kithunguriri. As a result of this there is one main cropping season. The climate is very suitable for tea production and tea is harvested almost throughout the year giving a steady monthly income to the household. The highest yields occur during the rainy seasons and are enhanced by fertilization. An example of a seasonal calendar from Kithunguriri is shown in Appendix 9.

All farmers in both FDAs have in common that they grow maize and beans. In Muthatari early maturing maize varieties are most common whilst in Kithunguriri most farmers plant slowly maturing maize. In Muthatari mango is grown commercially meanwhile it barely grows in Kithunguriri. This is because the climate in the two FDAs differs a lot.

4.2.3 Transect walk and Plot time line

The transect walk was important for the overall impression of the farm and to see if anything of importance had been forgotten when working with the other tools. Otherwise it was mainly for the botanical part of the study.

The field plot timeline was conducted in order to see when and what changes the farmers had made on each plot. The reasons for the changes were many and it is difficult to drawn general conclusions, especially anything related to climate. The reasons for changing included poor health, market prices and financial assets.

4.2.4 Problem - Solution Tree

The problems related to drought that the farmers experience differ a lot within the FDAs making it difficult to see trends. The team recognizes more drought-related issues in Muthatari. How farmers experience drought seems to be closely related to their wealth, e.g. a poor farmer might experience lack of drinking water and hunger, see Appendix 10, whilst a rich farmer experiences loss of income and shortage of irrigation water, see Appendix 11.

4.2.5 Summary – In-depth Interviews

No two interviews were alike. All farmers' situations are different and the teams' interview technique improved throughout the process. The results from the in-depth interviews helped confirming some of the assumptions made before the FGDs; (i) households with different income will have different strategies, (ii) the households' assets, such as land size, quality of soils and access to water will affect their strategies and (iii) the level of education will affect the strategies. The assumptions made when developing the in-depth-interview checklist, shown in Appendix 4, were also confirmed.

4.3 Questionnaires

The research team had GPS devices with the transect marked along which households should be selected. The actual position of the households were stored on the GPS device as well as written down on the questionnaire. In total, 39 households were interviewed in each FDA. The positions of the households are shown in Figure 9.

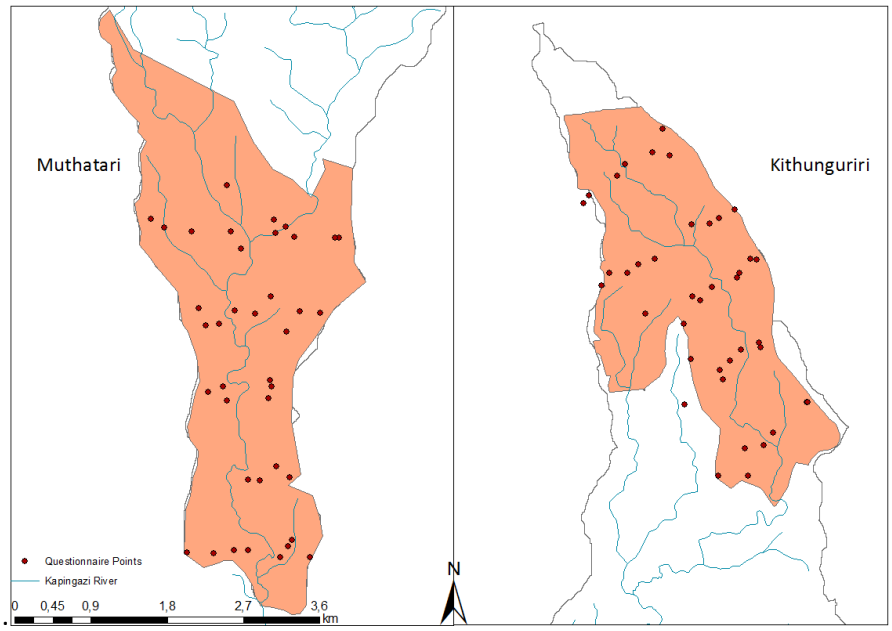

Figure 9. Position of households interviewed with questionnaire

The first section of the questionnaire was designed to target the socio-economic aspect of the interviewed households. Figures 10-12 illustrate three parameters that define wealth group: house-construction material, source of energy and domestic-water source. In Figure 13 the sizes of the farms are shown.

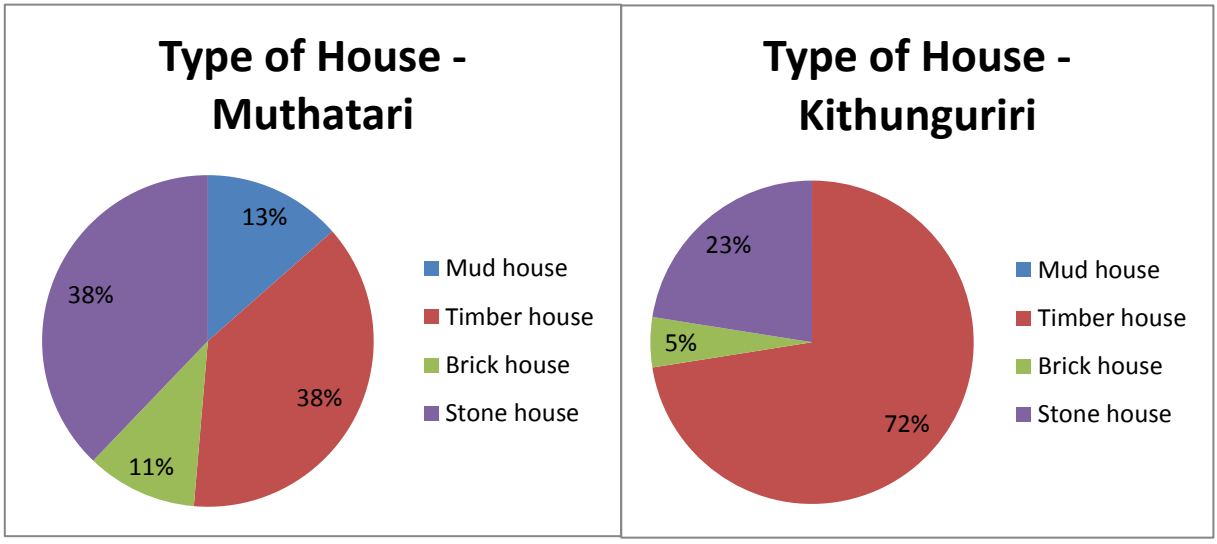

Figure 10. Wall-construction material in Muthatari (left) and Kithunguriri (right)

When answering the questions regarding energy source and domestic-water source, the interviewees could mark more than one option.

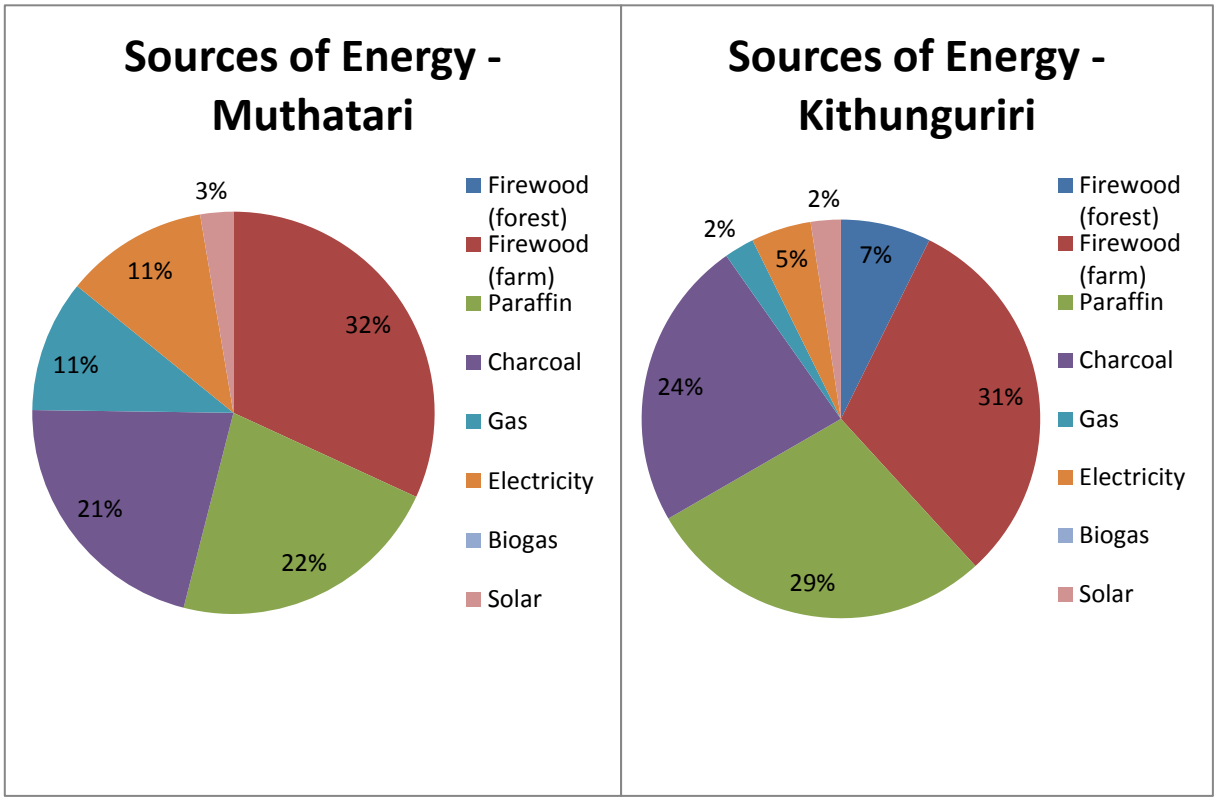

Figure 11. Sources of household energy in Muthatari (left) and Kithunguriri (right)

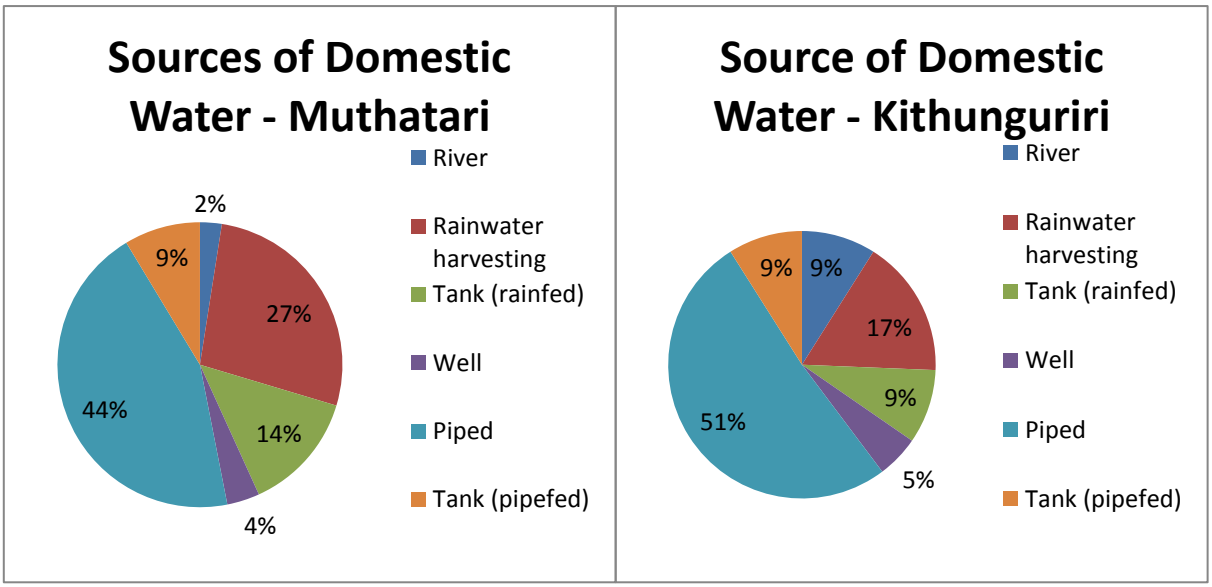

Figure 12. Sources of domestic water in Muthatari (left) and Kithunguriri (right)

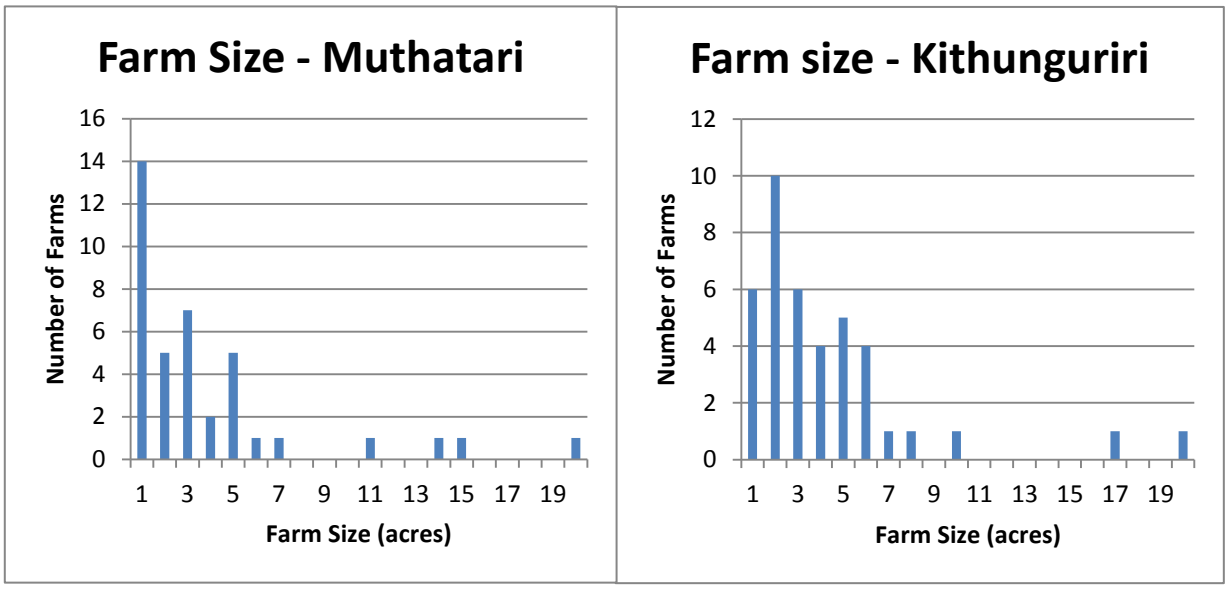

Figure 11. Farm sizes in Muthatari (left) and Kihthunguriri (right)

All interviewed farmers in both FDAs depend on rain to irrigate their farms. Some farmers use additional irrigation, shown in Figure 14. In Muthatari there was an irrigation scheme that provided some households on the west side of the river with piped irrigation water. The interviewed farmers could mark more than one option when answering the question about agricultural water.

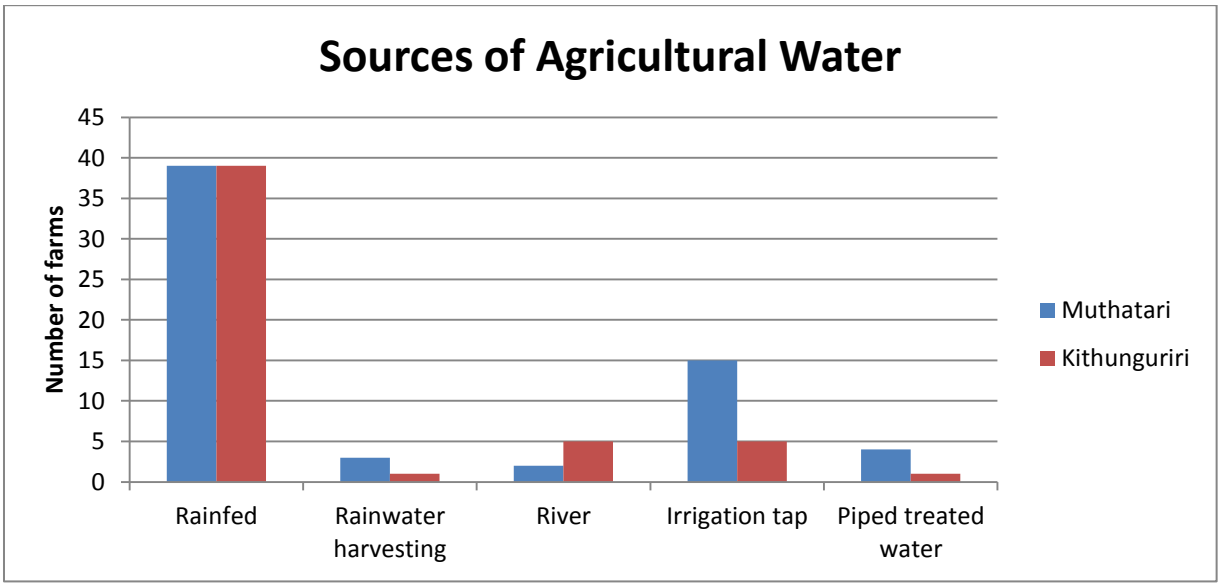

Figure 12. Sources of agricultural water in both FDAs

A number of drought-resistant crops were mentioned during the in-depth interviews. The team decided to include these in the questionnaire in order to see how common they were and to see if there had been an increase. As shown in Figures 15-16 these drought-resistant crops are more common in Kithunguriri than in Muthatari. Three of the crops were not found at all in Kithunguriri; millet, sorghum and cowpea. This may be due to a difference in climate as described in section 3.1.1.

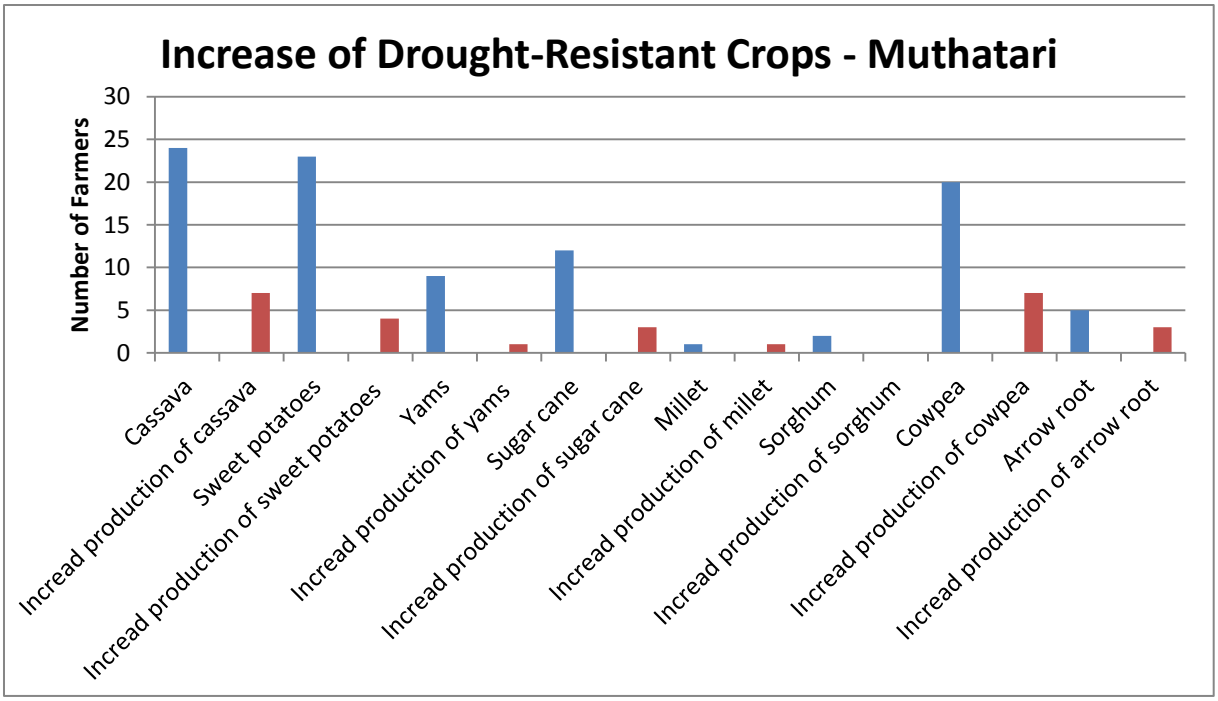

Figure 13. The number of farmers who cultivate certain crops (blue) and the number who have increased their production (red)

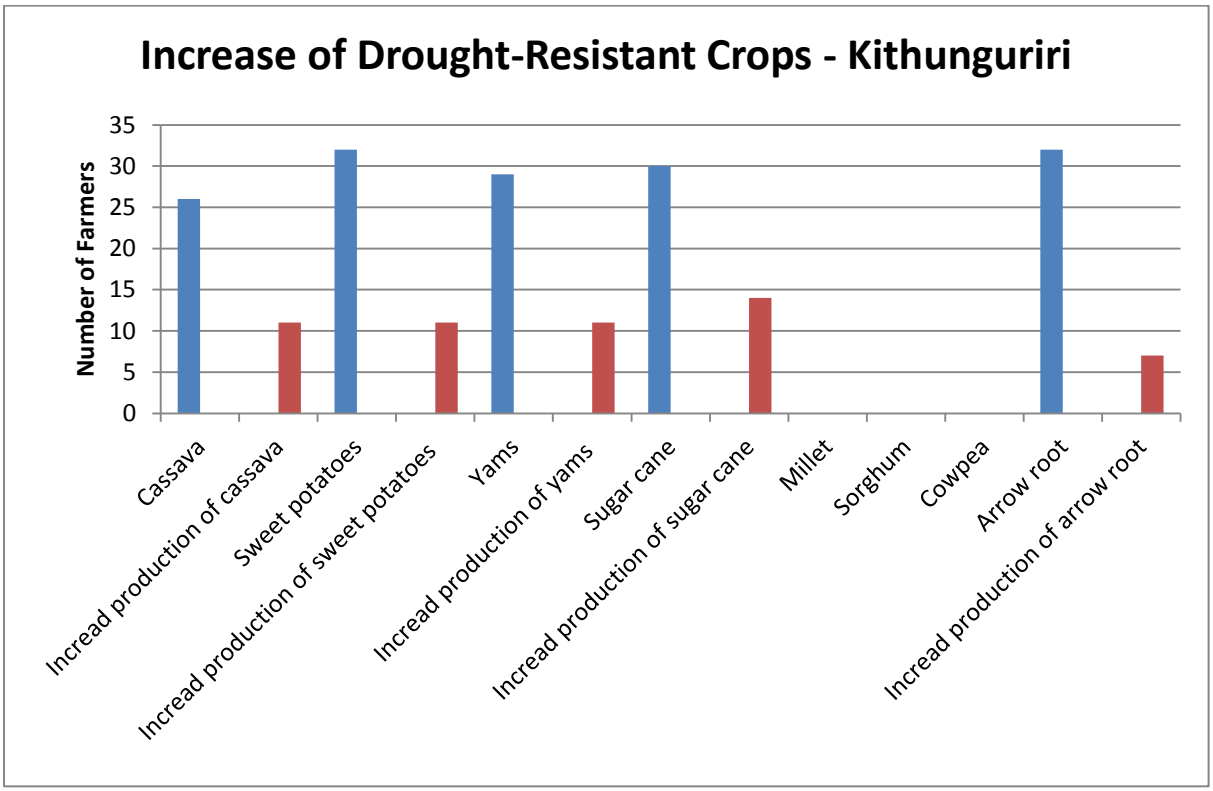

Figure 14. The number of farmers who cultivate certain crops (blue) and the number who have increased their production (red)

In Muthatari, a majority (67%) of the interviewed farmers did not get any net income from crops, see Figure 17, while in Kithunguriri all interviewed farmes got their main-crop income from tea. The farms having cash crops in Muthatari show a larger diversity, which make them less vulnerable to marget-price changes on a single crop. The total income from tea is much higher than from the other crops and gives a steady income every month, hence the farmers in Kithunguriri have in general a more reliable crop income than the farmers in Muthatari.

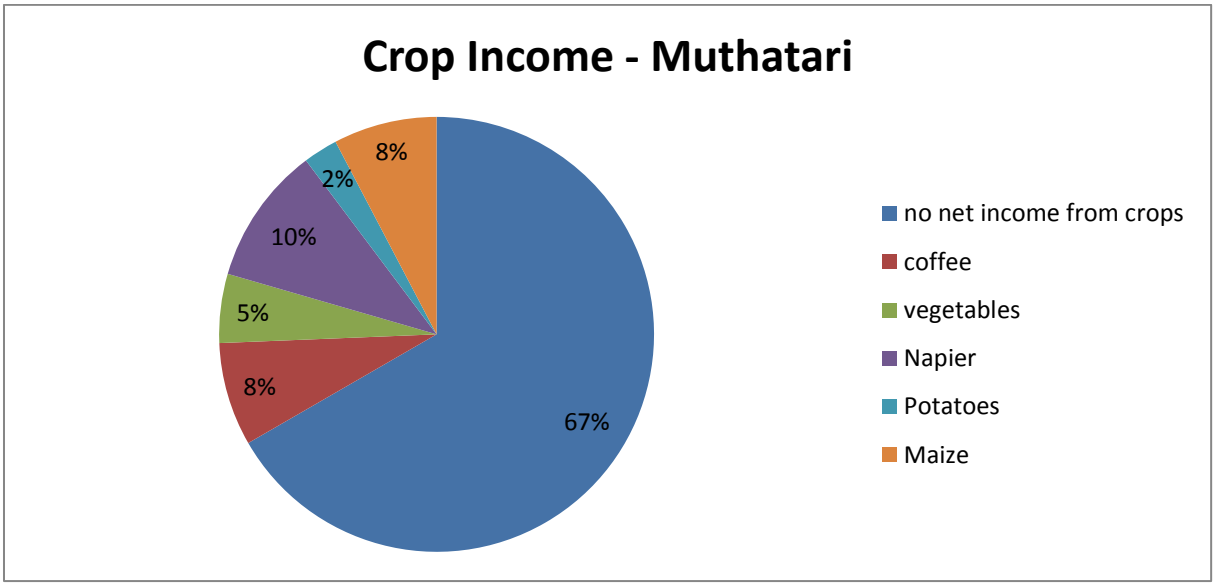

Figure 15. The crop that brings the most income to the households

Muthatari is more diverse than Kithunguriri when it comes to trees and other large plants that give fruits and nuts bringing income to the household, Figure 18.

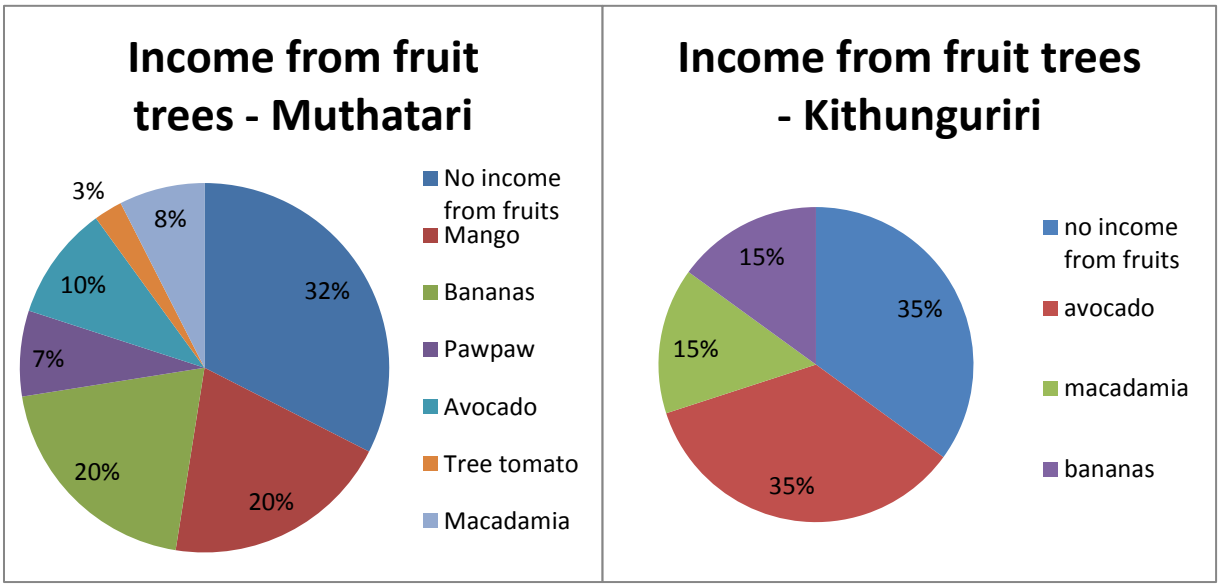

Figure 16. The trees that bring the most income to the households in Muthatari (left) and Kithunguriri (right)

In Muthatari, none of the interviewed farmers sold any livestock during the wet season, see Figure 19, while the farmers in Kithunguriri sold livestock during both seasons. It can also be seen that there were more farmers who owned livestock in Kithunguriri than in Muthatari.

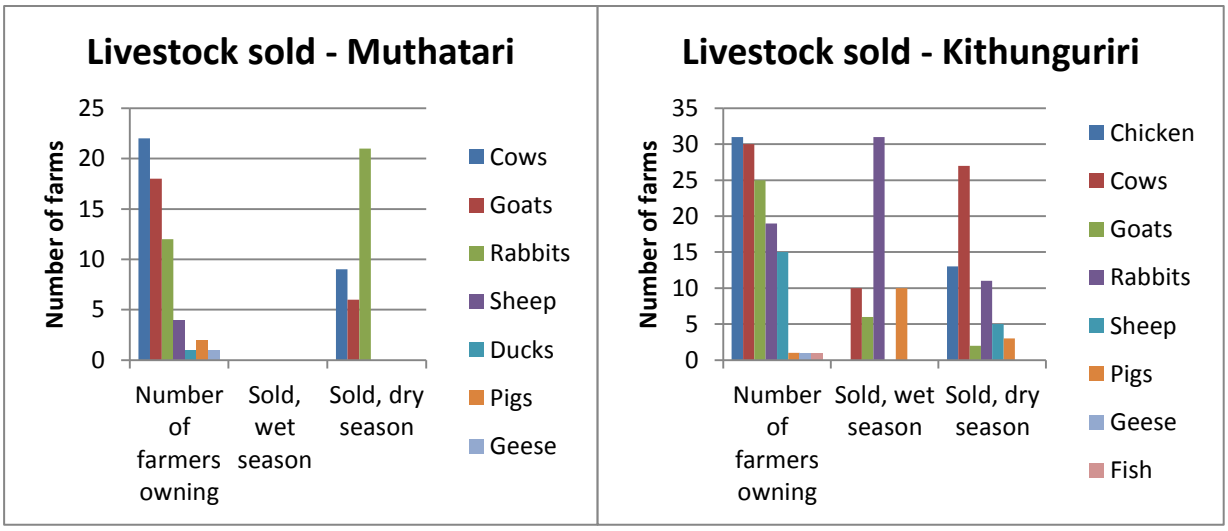

Figure 17. Number of farmers in Muthatari (left) and Kithunguriri (right) who own livestock. The middle and right categories refer to the number of animals that are sold

Dairy production occurs in both FDAs. In Muthatari, smaller quantities are produced and mainly sold locally whilst in Kithunguriri the vast majority sell milk to large dairy companies such as Brookside.

In both FDAs, casual labour is the most common off-farm activity. The columns in Figure 20 and Figure 21 are higher for the wet season than the dry because there are more jobs available then. Hawking means buying products and selling them at a higher price.

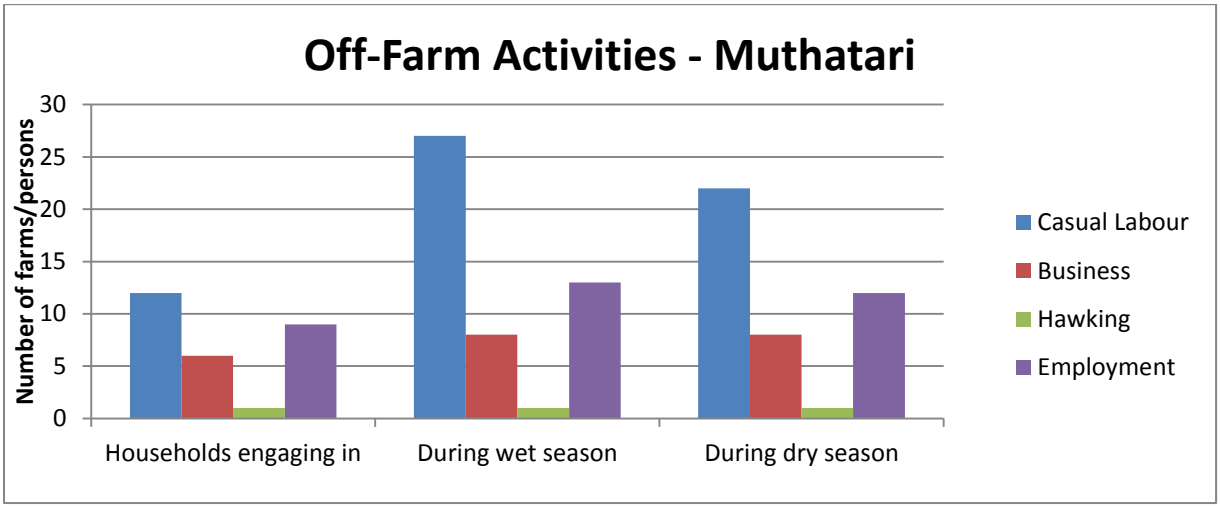

Figure 18. Off-farm activities in Muthatari. The left category shows the number of households engaged in each activity. The middle and right categories refer to the total number of people engaging in each activity during the wet and dry season

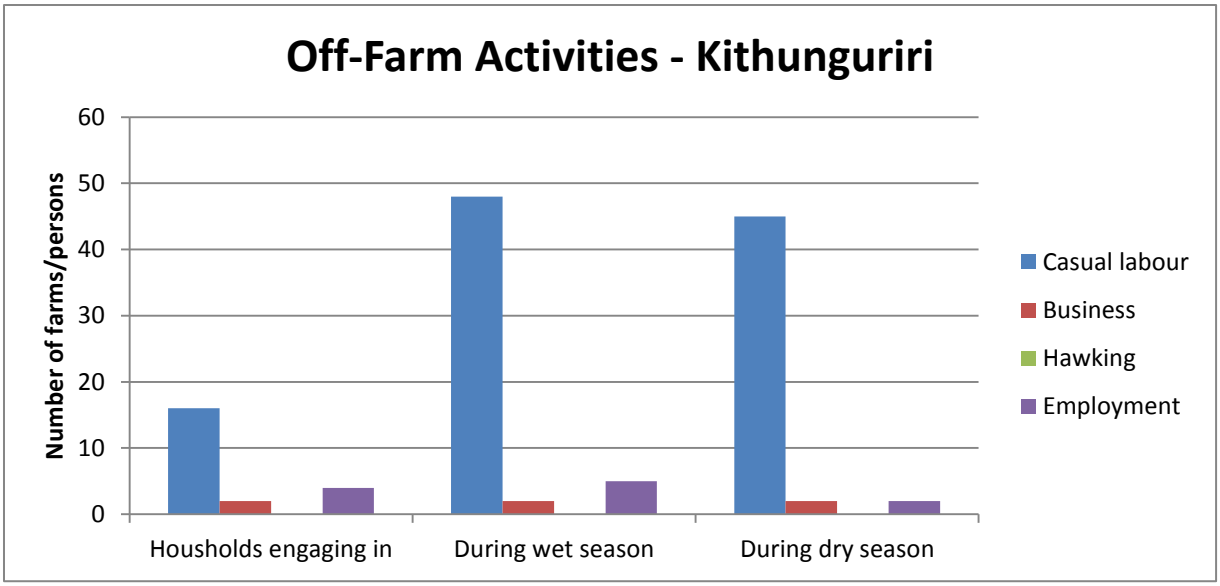

Figure 19. Off-farm activities in Kithunguriri. The left category shows the number of households engaged in each activity. The middle and right categories refer to the total number of people engaging in each activity during the wet and dry season

In each FDA 39 farmers were interviewed. In Muthatari a large portion of the farmers interviewed answered that they have experienced more severe dry seasons in later years, as shown in Figure 22. In Kithunguriri fewer farmers had experienced more severe dry seasons, but they had more strategies for coping with and adapting than in Muthatari, as shown in Figure 23.

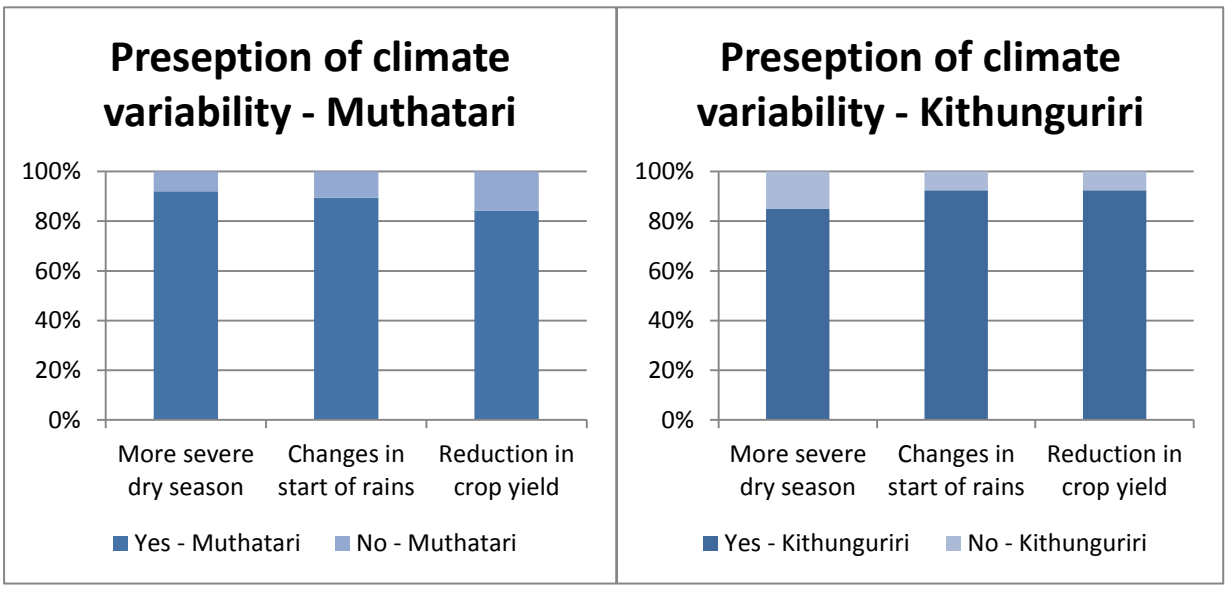

Figure 20. The percentage of farmers who have experienced three indicators of climate variability in Muthatari (left) and Kithunguriri (right)

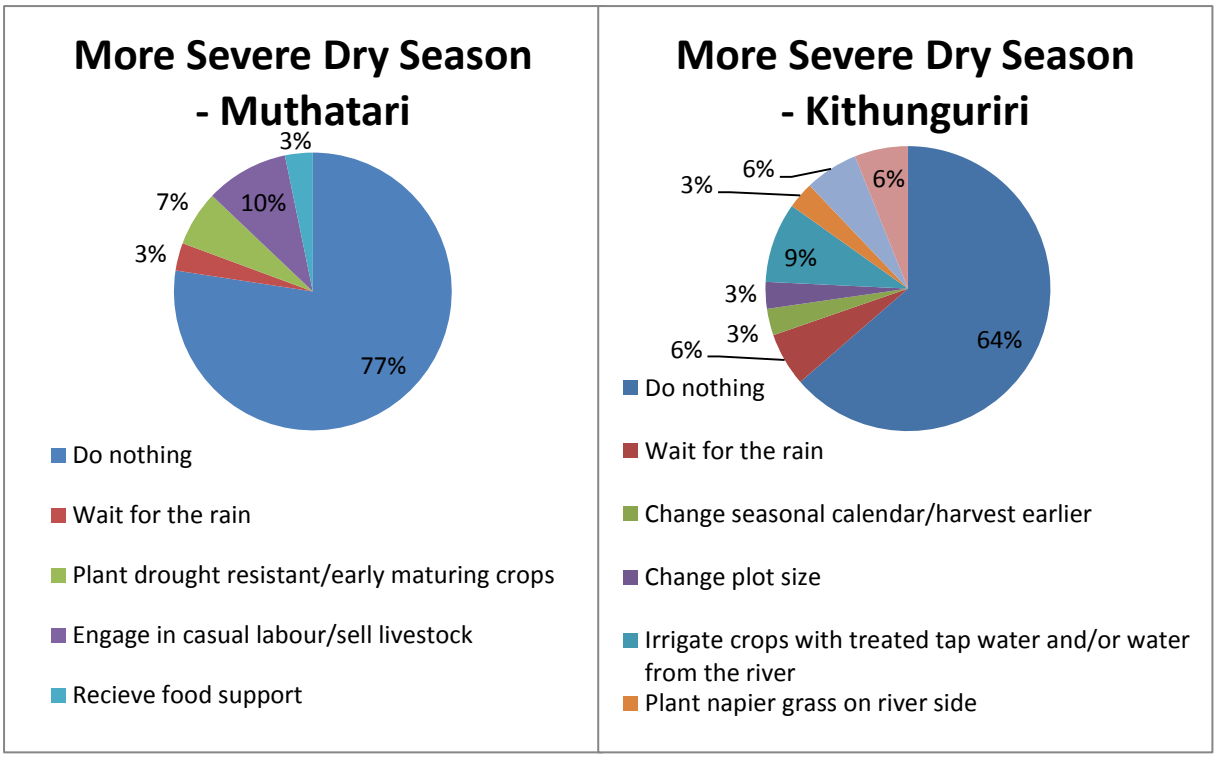

Figure 23. Strategies to cope with and adapt to more severe dry seasons in Muthatari (left) and Kithunguriri (right)

Figure 24 shows that there are more strategies to cope with or adapt to the changes in the start of the rainy season in Kithunguriri than in Muthatari. Part of the difference could be because the river does not dry out in Kithunguriri as it has done in Muthatari. The relatively large portion of farmers in Kithunguriri that irrigate their crops could be due to the short distance between cultivation site and the river.

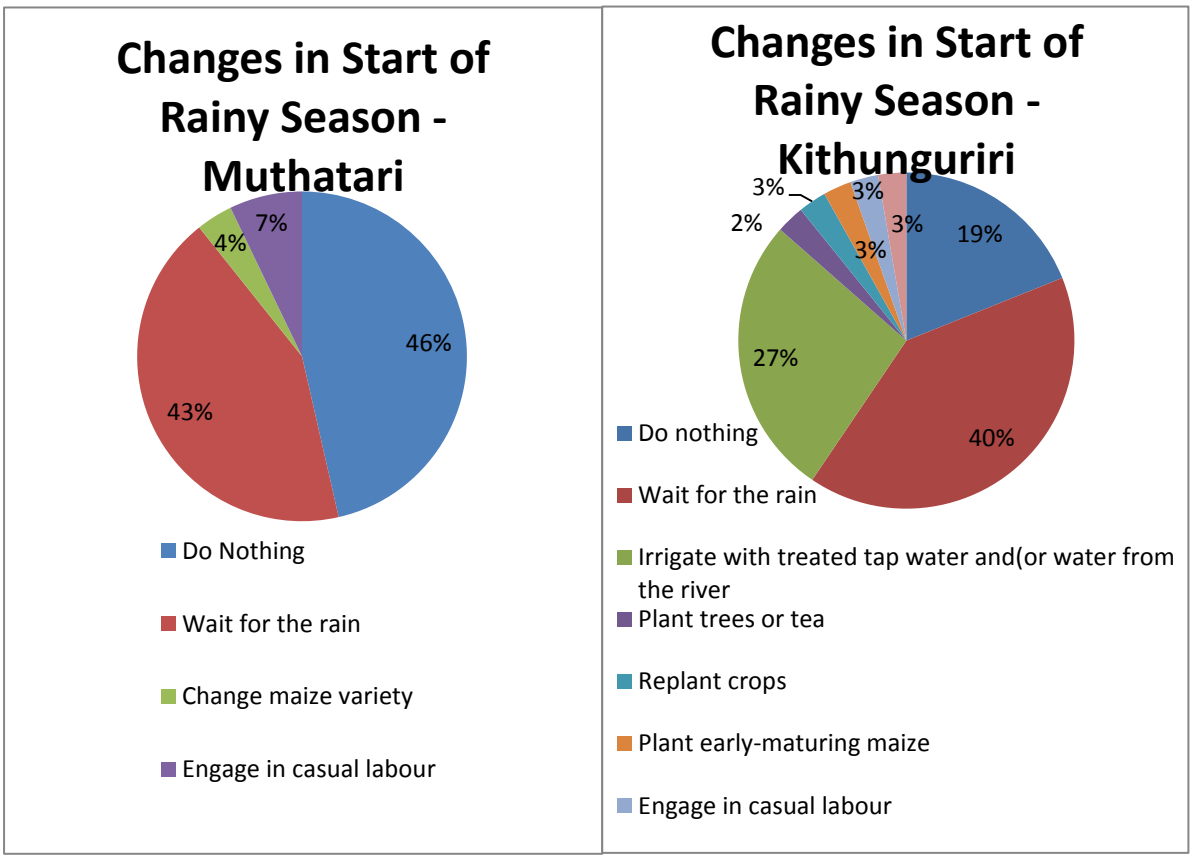

Figure24. Strategies to cope with or adapt to changes in the start of the rainy seasons in Muthatari (left) and Kithunguriri (right)

In both FDAs the main strategies when it comes to reduction in crop yield were to do nothing or to buy food from the market, Figure 25. Two long-term strategies mentioned were planting drought-resistant crops and applying fertilizer. The other strategies are mainly coping strategies.

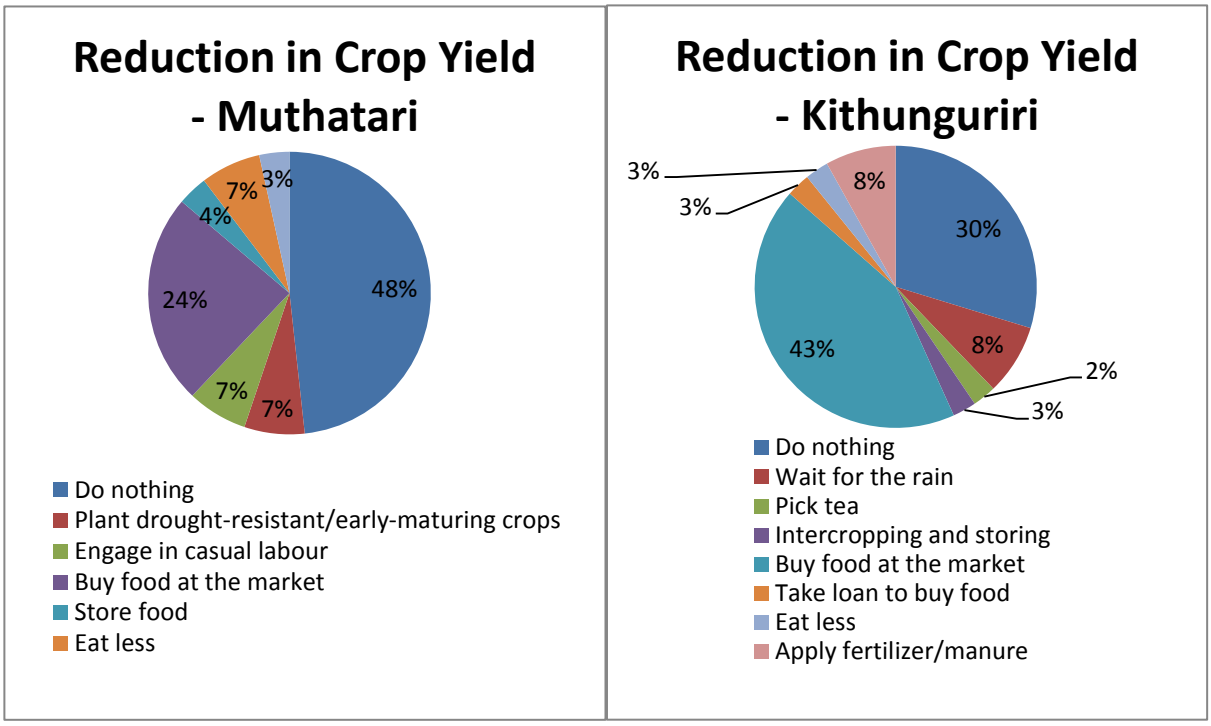

Figure 25. Strategies to cope with or adapt to a reduction of crop yields in Muthatari (left) and Kithunguriri (right)

5 Conclusions

The following conclusions could be reached from the results:

- The vulnerability towards climate variability of the farmers varies between as well as within the different FDAs, the farmers in Muthatari perceive more severe dry seasons than the farmers in Kithunguriri. The difference in vulnerability showed, during the in-depth interviews, also to be related to the farmers' wealth.

- It is not possible to see a correlation between the land-use upstream and the water availability downstream. However, a connection between over-abstraction of water upstream and drying of the river downstream was found by the hydrological part of the research team.

- The farms in Muthatari are much more diverse than in Kithunguriri. A reason is a combination of factors such as access to markets as well as it being an adaptation strategy towards climate variability. In Kithunguriri the farms are intensifying in tea production, which is due to the suitable climate as well as the good market prices.

- In general more adaptation strategies were found in Kithunguriri.

- The number of people who engage in off-farm activities, such as casual labour, is not a coping strategy since the demand for labour is a regulating mechanism.

- The farms in both FDAs are mainly rain fed but when it comes to irrigation they differ. In Kithunguriri cultivation near the river is relatively common. Irrigation of these plots is a strategy used when the rainy season does not start when expected. In Muthatari there is an irrigation scheme where the farmers can pay to connect to an irrigation tap. This results in only a part of the community being able to access the irrigation water.

- The selected PRA tools proved successful in giving results in this study.

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Appendix 1 – Checklist Focus Group Discussion

Target	Tool	Objective	Assumption	Checklist
Focus Group Discussion with key informants: FDA leader, 4 committee members that are scattered in the landscape (2 men, 2 women)	Wealth ranking – poverty parameters Stages of progress	To select households to interview Reason for a strategy (related to overcome poverty)	1. Households with different income will have different strategies. 2. The education level will affect the strategies 3. The households' assets, such as land size, quality of soils and access to water will affect their strategies	○ **FGD** will put 3 names each (poor, medium, rich) for wealth ranking. First themselves then two others ○ **Houses** • Walls • Roofs • Energy source ○ **Farm size** ○ **Education level of household head** ○ **Family** • How many depend on the farm (live, eat, etc.) ○ **Income** • Amount • Sources (mills, mobile phone charging, crops, etc.) ○ **Production** • What crops • How much? yield, area, how many plants • For what: subsidence, income ○ **Access to water:** • **Human:** tap, well, river, rain water harvesting, borehole • **Livestock:** tap, well, river, rain water harvesting, borehole • **Agriculture:** rain fed, irrigation ○ **Soil fertility, slope, workability** ○ **Off farm jobs** • Casual employment (for other farms) • Own business? • Formal employment (salary) ○ **Livestock:** cows, goats, sheep, pigs, poultry, rabbits, oxen • Farm structure (zero-grazing etc.)

				○ **Dependence on forest** • What? (grass, firewood, beehives) • How often? ○ **Trees** • What (species) • How many • For what: household use (firewood, timber) or cash
Target	**Tool**	**Objective**	**Assumption**	**Checklist**
Focus Group Discussion with key informants: FDA leader, 4 committee members that are scattered in the landscape (2 men, 2 women)	FDA sketch	Select households	1. Wealth and hotspots are related 2. Hotspots and strategies related	○ **Team:** • Borders • Rivers • Roads (main) • Commercial centres (local names) (Embu) ○ **FDG:** 1. Own houses 2. Schools & churches as reference points 3. Local names 4. Markets – Agricultural products (tea, coffee, vegetables, cereals, timber, horticulture – Livestock products (diary, meat) – Stones (quarries) 5. Irrigation system Any big woodlots? Hills 6. Best and worst field: – Yield – Quality – Where to buy – WHY????? (Erosion, fertility, water) Origin of the cause => Hotspots & filter points

Target	Tool	Objective	Assumption	Checklist
Focus Group Discussion with key informants: FDA leader, 4 committee members that are scattered in the landscape (2 men, 2 women)	Village timeline/History	Reference point on key issues for the strategies	1. Conditions have been changing 2. Large scale changes affect local strategies	○ **Basic** • Year of establishment of the 1st household - Resettlement • Household number evolution ○ **Focused** • Institutions – Cooperatives – Microfinance – Water (WRUA) – Forest (CFA) • Programs/Projects (development, support) – Extension – Subventions – Loans – MKEPP – Tree planting • Coffee • Tea • Land allocation • Tree cover/patches evolution • Droughts • Floods • Policies – Forest access • Markets – Agricultural products (tea, coffee, vegetables, cereals, timber, horticulture) – Livestock products (diary, meat) – Stones (quarries) • Infrastructure – Irrigation – Roads

				– Domestic water • Communication • Employment emigration to urban areas (off-farm)
Target	**Tool**	**Objective**	**Assumption**	**Checklist**
Focus Group Discussion with key informants: FDA leader, 4 committee members that are scattered in the landscape (2 men, 2 women)	Venn Diagram	Find institutions that • Influence the strategies • Make the strategies possible • Act as strategies	1. Institutions add up/improve the social assets of the farm 2. Farmers might associate to institutions when thinking of issues regarding coping with water scarcity (climate variability)	**Topic:** Drought ○ That build irrigation (+) ○ That do research - provide information (crops, animals, weather forecast) (+) ○ Cooperatives (+) ○ Water abstractions (-) ○ Water abstraction regulations (+/-) ○ Microfinance (+) ○ Community forest association (CFA) (+) ○ Development programs/projects (govt., NGOs, etc.) (+) ○ Community self-help groups (+) ○ Capacity building ○ Humanitarian assistance/food aid (red cross, world vision, care, UNICEF, Plan International)

Appendix 2- Wealth Ranking - Muthatari Focus Group Discussion 15.04.2011

Lower Class	Middle class	Upper class
Stay in slums, mud-wooden houses/rent houses	Wooden, brick, stone houses	Big and equipped mansion (Stone house)
No land of their own. Rent land for planting (maize, beans and cassava seasonal)	1-10 acres of land	>10 acres (Big farm)
No businesses	-	Has a famous business. Have rental houses (Stone)
Employed casual labourers	They employ 1-2 workers. Give part time jobs	Has employed a lot of people
Have hand-carts	Have bicycle, motor vehicle, motorcycle (second hand) Have donkey-cart or oxcart. Possess a plough.	Drive expensive vehicles (new)
No livestock, no cows, no poultry	Dairy farming	Dairy cattle (over 10 heads). Does poultry keeping.
No security	-	Have tight security both daytime and night time. Have electric fences.
Charcoal or firewood from reserve areas	They use gas, electricity, firewood as sources of energy	Use gas, electricity, biogas and firewood as sources of energy.
<200 KSh/day	-	
Make houses in the riparian areas or free land allocated by the local authorities	-	Live in flat areas
Given trees by authorities	Plant trees and buy trees for construction	Buy trees
Collect metal, plastic, containers, and paper bags to sell	-	-
> 6 children	3-5 children	Have fewer children
Lack food most of the time. Food donations from NGOs	They have enough food.	Have excess/surplus food which is sold.
Sell napier grass from reserves to upper class	They can produce subsistence food and cash crops: coffee, maize, beans, bananas, sweet potatoes, tomatoes	Plant commercial tissue bananas, mangoes, coffee, paw paw (papaya), maize, beans, sweet potatoes, melons, passion fruit,

		cabbages, trees (buy seedlings), woodlots
Children don't go beyond primary school education	Educate their children up to secondary school. Some reach tertiary education level such as colleges and training institutes and a few universities.	Has well educated children. Take children to private school.
No access to clean water (unless they sympathized with middle class): river, well	They have clean water (pipes)	They have clean water (pipes)
No irrigation	Have irrigation systems and water pumps	Have irrigation systems and water pumps.
High incidence of infectious diseases: malaria, intestinal worms, typhoid, cholera, diarrhoea, kwashiorkor, marasmus	-	-
Beggars, thieves, drunkards (local brewers)	-	Self-sufficient
Drug abuse (mirra, bhang, smoking)	-	Take beer, whisky and wine.
Self medicate using herbs from forest and bushes in farms.	-	-
-	Possess TVs, radios, mobile phones, telephones.	Have satellite dishes, internet, mobile phones, computers.
-	-	Have passports to travel abroad

Appendix 3 - Wealth Ranking - Kithunguriri Focus Group Discussion 20.04.2011

Poor Person (Muthini)	Normal person (Kawaida)	Rich Person (Gitonga)
Mud/Timber house (low quality timber)	High quality timber house/mud bricks/ Plastered mud houses	Have stone houses and high quality timber
Iron sheets, drum cylinder for roofing	Iron sheets for roofing	Iron sheets for roofing as well as tiles
No cement floors, mud floors	-	-
Use water from the river for domestic use	Have piped water for domestic purposes	Use domestic water, roof harvested water for irrigation
Firewood, paraffin for fuel	Firewood for cooking/gas cookers Paraffin for lighting Depend on the forest for firewood	Use electricity, solar, gas for cooking, firewood (biomass)
Land size not important Some have below 3 acres but don't take care of the farm	Own 3 acres and below of land	Own over 10 acres of land
Some stay in the farms where they are employed	-	-
Mostly primary level education	Some are educated up to secondary level	Some are not educated especially those with big farms but their children are educated up to tertiary education/institutions
Big families, even 10 children	Have between 3 and 4 children	Some have big families
Casual labour	Some are employed, others work on their farms	Are employed
Income from casual labour 60 - 150 KSh/day 5 - 7 KSh per kg picked tea Don't depend on children	Source of income – tea farms, livestock, horticulture, micro-businesses	Sources of income – a lot of tea, keep livestock, rental houses, from children living abroad, from coffee, trees
Some have some tea others lease their farms	-	-
Have sukumawiki (kales)	-	Have well established horticulture farms: Produce cabbages, kales, carrots, tomatoes and flowers
Poor managed farms. No fertilizer, lots of erosion	Plant napier grass for fodder along the strips	Every part of land is utilized
-	-	Plant whole section for fodder (napier) Also buy napier

-	Honey from the forest	-
Trees for fuel and selling Sell eucalyptus to brokers for construction support	Have woodlots on their farms where they sell trees	Have woodlots – eucalyptus & grevillea (bigger size for prestige)
No livestock Some have rabbits, 2 to 3 chicken	-	Keep cattle, chicken, exotic goats, rabbits
Not enough food	Not as much food as the rich	Plenty of food

Appendix 4 - Checklist In-Depth Interviews

Target	Tool	Objective	Assumption	Checklist
Individual farmers	Farm sketch (20 min)	Find out current land uses	1. Current land uses might be the result of adaptation strategies (as well as other influences)	○ Homestead and farm structures (zero grazing unit, …) ○ Crops • Cash - Perennial (coffee, tea) - Annual (cassava, sweet potatoes) - Seasonal (maize, beans) • Food - Perennial (fruit, trees) - Annual (cassava, sweet potatoes) - Seasonal (maize, beans) ○ Grasses (napier, …) ○ Trees • Woodlots • Agroforestry • Why did you plant trees? (for harsher times, because you received seeds from organisation etc.) ○ Water • River • Irrigation (SUTTLE: do they use domestic water for irrigation?) • Pipes • Wells • Rain harvesting (size) ○ Home/Kitchen garden (species) ○ Access • Roads • Paths ○ Electricity ○ Livestock • Water: from where? How much?

				○ Mark the transect ○ Size of plots (acres) ○ WHY???
Target	**Tool**	**Objective**	**Assumption**	**Checklist**
Individual farmers	Seasonal calendar (20 min)	See how the crop calendar changes when the rain pattern changes (less, later)	Farmers modify the calendar/species to adapt	○ Normal year ○ Normal period of rain • When do you have a lot of rain • When do you have no rain ○ Deviation from normal year • What happens if you have less rain • What happens if the rain comes later ○ Crops: seasonal (maize, beans), annual (cassava), perennial (coffee, tea, bananas, trees) • Planting • weeding • harvesting • fertilizing
Target	**Tool**	**Objective**	**Assumption**	**Checklist**
Individual farmers	Problem tree (20 min)	Find out the problems and solutions related to drought.		○ Problem • Smaller yields • Lack of moisture → crop failure • Increase of pests and diseases • Livelihoods - Less money - Less/no food • Lack of drinking water →more time to harvest water → less time to work on the farm. ○ solutions • Planting drought-resistant crops - Cassava - Yams • Reduce the amount of food to keep stock for a longer time:

				- Improve food storage - Insecticides for food storage • Buy water (jerry cans) from the boreholes (vendors) (Plan International) • Farmers upstream buy land downstream for vegetable production so that they can use as much land as possible upstream for tea • Beehives are put in the forest where more water is available • Location of varieties is shifting (e.g. maize is going up) • (Village history) - Improving social assets/networks - using phones to know where to get food and what prices - associations/collaboration (buy a sack of maize together and divide) - humanitarian assistance (Americans came with maize, churches provide food, middle class give to lower e.g. clean water
Target	**Tool**	**Objective**	**Assumption**	**Checklist**
Individual farmers	Transect walk (1h 30 min)	1. Get coordinate to input in GIS – corners of farm, fields – hotspots, filter point 2. See what species are on the farm 3. See the evolution of hotspots/filt		○ 2 transects (unless it is not necessary: small or narrow farm) ○ Cross hotspots/filters points ○ Tree based plots/areas ○ Coordinates ○ Soil • Team: colour • Team: texture • Team: moisture • Farmer: workability (easy or hard for planting) ○ How well do the crops grow? Why? (fertility, water) ○ Resource species • Trees, grasses, crops • Team: density

		er (timeline)		• Team: estimate number of trees • Farmer: size of woodlot • (comments) ○ Topography • Slope (GPS, estimate) • (concave, convex, terraces, flat) ○ Water source ○ What happens with (~~heavy~~) rain? ○ In case of **erosion-prone areas**: what do you do to cope/prevent it? • If we see current strategies (terraces, contour cultivation agroforestry), ask WHY? SINCE WHEN? • ASK if they are happy with the strategy? If not, what would you like to do instead? ○ In case of **dry areas or other key issues**: what do you do to cope/prevent it? ○ Pictures • Transect • Plot • Soil (profile if possible) • Species
Target	**Tool**	**Objective**	**Assumption**	**Checklist**
Individual farmers	Plot timeline (during transect walk)	See how crops have changed over years		○ All fields passed during the transect walk • Hotspots: lack of water • Filter: enough water • Home garden ○ Include crops (if this is the case) (2 years) ○ Previous land use in the same plot for the last 35 years

Appendix 5 - Questionnaire

Enumerator: _____ Code: _____

Date:_____/_____/_____(date/month/yr) Time: _____/_____ (hh/mm)

FDA: Kithunguriri ( ) Muthatari ( )

Homestead GPS coordinates: _____S _____E, Altitude _____

Name of Respondant:_____ Age:_____

Sex: Male ( ) Female ( )

Household head: Yes ( ) No ( )

If no, Name of household head: _____ Age: _____

Level of education of HH head: none ( ) primary ( ) secondary ( ) post-secondary ( )

Household:

How many people live on the farm (including children)? _____

(Tick = Yes No tick = No)

Homestead		Owned Transport		Source of energy		Domestic water source		Equipment	
Mud house		Hand cart		Forest firewood		River		Mobile phone	
Timber house		Ox cart		Farm firewood		Rain harvesting		Radio	
Brick house		Bicycle		Paraffin		Storage tank fed by rainwater		TV	
Stone house		Motorbike		Charcoal		Well		Computer	
Rented house		Second-hand car		Gas		Piped		Internet/Modem	
Owned house		New car		Electricity		Storage tank fed by pipe		DSTV	
Irrigation tap				Biogas				DVD player	
Zero grazing unit				Solar					

Farm:

Total farm size: _____ acres

When did you settle on this land? Year: _____

Type of farming: (*tick only one)* Commercial ( ) Semi-commercial ( ) Subsistence( )

Irrigation

What are the sources of water for your crops? Rainfed( ) Rain water harvesting( )
River/stream( ) Irrigation tap ( ) Treated piped water ( )

Do you water your crops? Yes ( ) No ( )
If yes, which crops?_____

When? Dry season ( ) Rainy season ( )

Drought resistant crops:

Do you have … on your farm?

Name	Now Y/N	Since when?	Have you increased the production? Y/N	Since when?	Use e.g. subsistence, fodder, cash:
Cassava					
Sweet potatoes					
Yams					
Sugar cane					
Millet					
Sorghum					
Cowpea					

	Now Y/N	Since when?	Have you increased the production? Y/N	Since when?	Variety/ies:	Use e.g. subsistence, fodder, cash:
Banana						
Maize						
Arrow root						
Beans						

Cash/food/fodder crops:

Have you had … on your farm during 2010?

Crops:		Size of plot (acres)	When did you start? (year)	Production in 2010 (kg)	Expenses during 2010 e.g. fertilizer, seeds, etc (KSH)	Volume sold during 2010 (kg)	(gross) Income during 2010 (KSH)
Tea							
Coffee							
Vegetables							
Napier							
Others							
	Variety						
Maize (var1)							
Maize (var2)							
Maize (var3)							
Maize (var4)							
Beans (var1)							
Beans (var2)							

Trees and fruits:

Do you have trees on your farm? Yes ( ) No ( ) If yes, which trees did you get food or income from during 2010?

	Trees:	Number of trees	When did you start? (year)	Production in 2010 (kg)	Expenses during 2010 (KSH)	Volume sold during 2010 (unit)	(gross) Income during 2010 (KSH)
Fruit	Macadamia						
	Avocado						
	Pawpaw						
	Mango						
	Passion fruit						
	Tree tomato						
Multi-resource	Banana						
	Trees:	**Number of trees**	**When did you start? (year)**	**Trees cut down in 2010 (number)**	**Expenses during 2010 (KSH)**	**Trees sold during 2010 (number)**	**(gross) Income during 2010 (KSH)**
Timber/charcoal trees	Grevillea						
	Eucalyptus						
	Cypress						
	Cordia (*kiembu*)						

Livestock

Do you have livestock? Yes ( ) No ( ) If yes, what do you have?

Livestock:	Number of animals	Expenses during 2010 e.g. fodder (grass, concentrates) vet. (KSH)	Number sold during 2010 and when? Wet	Dry	Total earnings during 2010 (KSH)	Free grazing? (Y/N)
Chicken						
Cows						
Goats						
Rabbits						
Sheep						
Ducks						
Pigs						

	Production during 2010	Amount sold during 2010	Total earnings in 2010 (KSH)	Expenses during 2010 e.g. grass, concentrates, vet. (KSH)	Lowest price? (KSH)	When? (month)	Highest price? (KSH)	When? (month)
Cow milk	l/day	l/day						
Goat milk	l/day	l/day						
Eggs	/week	/week						

Who are you selling to?

_____

Off-farm income:

Did anyone in the household do off-farm activities in 2010? Yes ( ) No ( ) If yes, what type?

Activities:	How many people do … during wet season?(pers)	Frequency during wet season (day/week)	Income during wet season (KSH/day and pers)	How many people do… during dry season?(pers)	Frequency during dry season (day/week)	Income during dry season (KSH/day and pers)
Casual labour						
Business						
Hawking						
Employment						
Other:						

Other plots:

Do you have plots away from your farm? Yes ( ) No ( )

Plot	Location	Since when	Size (acres)	Main crop	Main use: e.g. subsistence, fodder, cash, etc.
1					
2					
3					
4					
5					
6					

Climate variability:

Which of the following have you noted since you settled in this farm?

INDICATORS	Y/N	How have you addressed it?
Drying of rivers/streams		
Big change in the start of the rainy season		
Changes in rainfall amount		
More severe dry season		
More severe cold season		
IMPACTS	**Y/N**	**How have you addressed it?**
Reduction in crop/fodder yields		
Increase of plant pests and diseases		
More serious livestock diseases during dry season		
Decrease in livestock productivity		
More difficult to find a job during dry season (before vs now)		
More expensive farm labour/employees		

Do you know who to contact to get answers to your questions regarding these issues?

Yes ( ) No ( ) If yes, who?

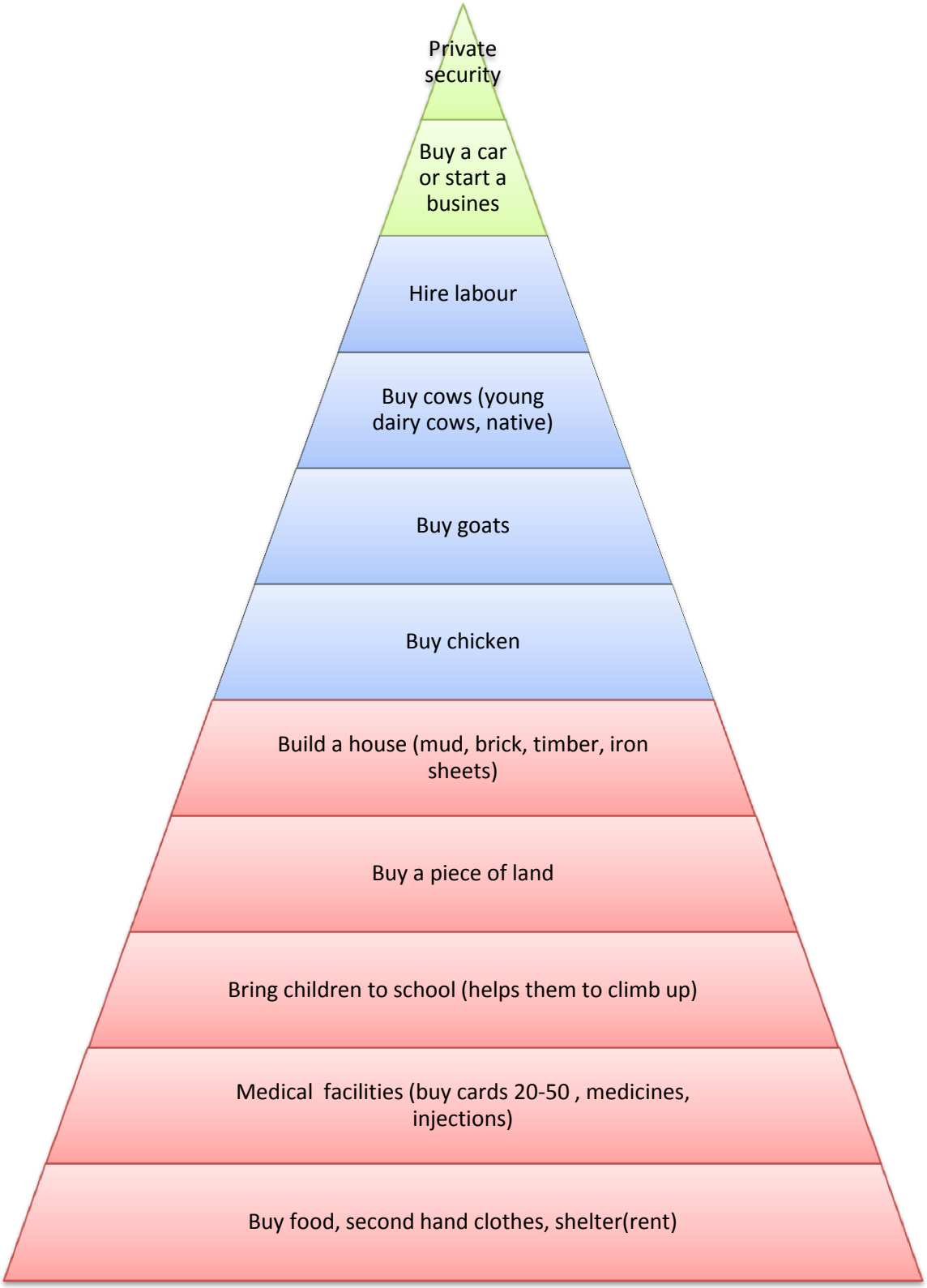
_____

_____

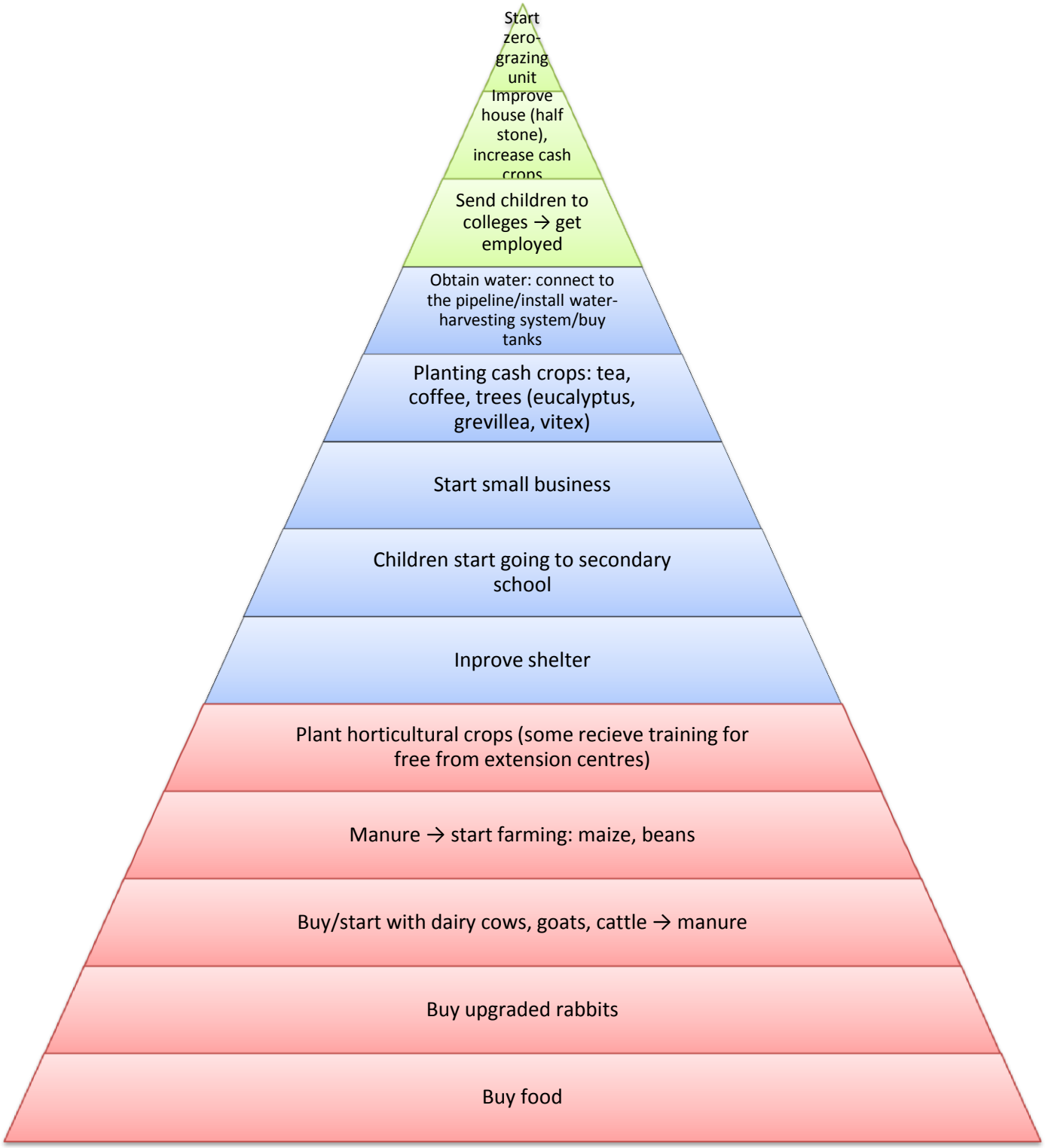
_____

_____

Appendix 6 - Stages of Progress - Muthatari Focus Group Discussion



Appendix 7 - Stages of Progress - Kithunguriri Focus Group Discussion



Appendix 8 - Seasonal Calendar - Muthatari In-Depth Interview

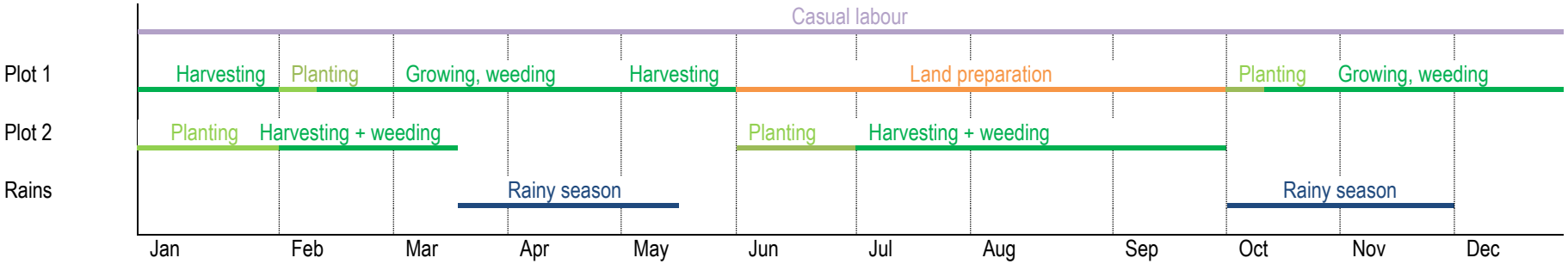


Figure Seasonal Calendar:

Casual labour: The wife and the two oldest sons go for casual labour throughout the year.

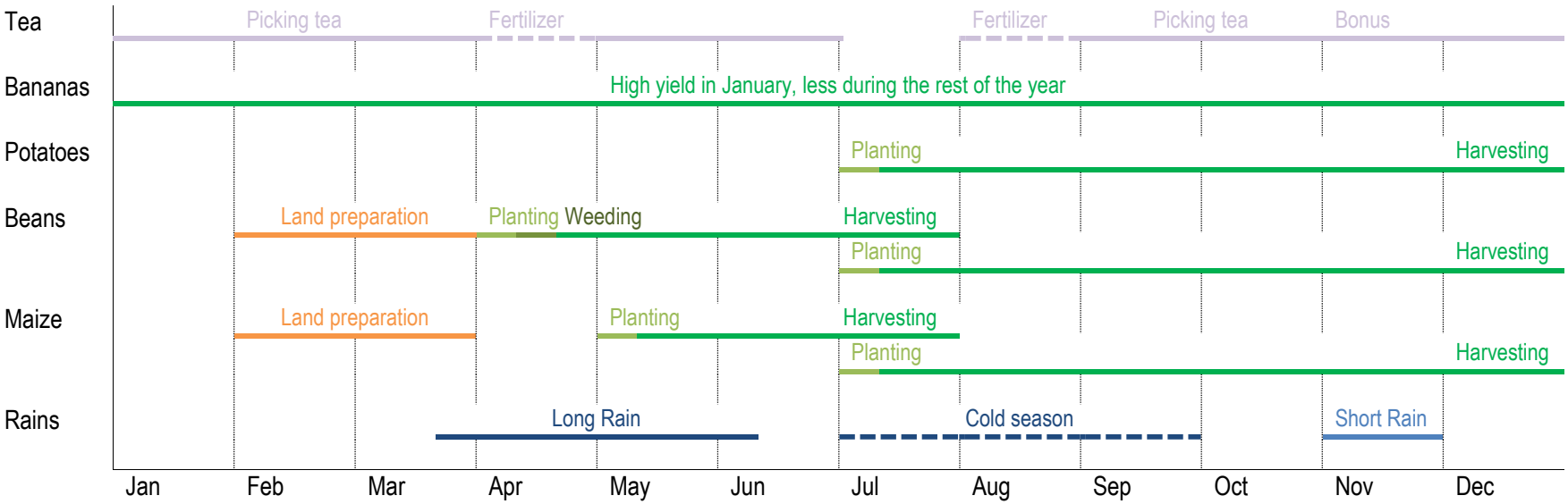
Plot 1:

Crops: Maize and beans

Plot 2: They only plant vegetables if they have enough money to buy seeds, the vegetables can be harvested one month after planting.

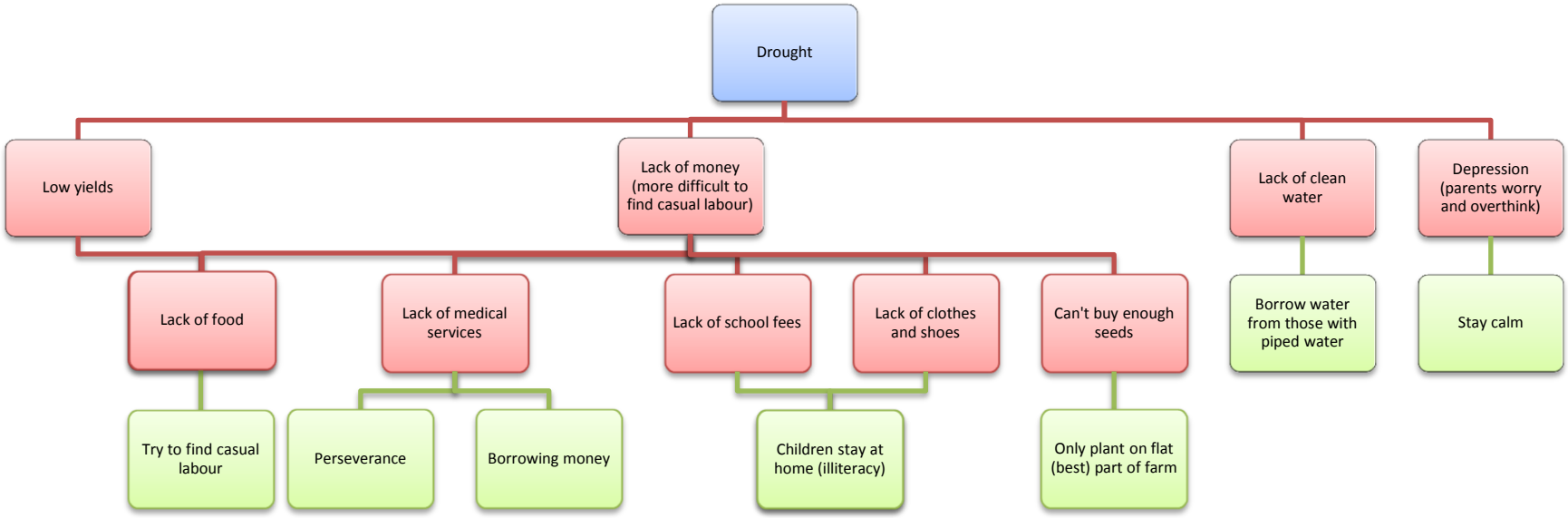
Crops: Vegetables e.g. Kales.

Appendix 9 - Seasonal Calendar - Kithunguriri In-Depth Interview



Tea:	Income throughout the year. The bonus in November is used for school fees for her son (in high school). Pruning during July.
Beans:	Applying fertilizer when planting in April
Maize (Variety: 614):	Applying fertilizer when planting in May If the farmer knows it will be dry she changes the variety to more drought-resistant varieties; Nduma, Pioneer or Pana.
Other sources of income:	Goes for casual labour throughout the year, more difficult when it is dry

Appendix 10 - Problem Tree - Muthatari In-Depth Interview



Appendix 11 - Problem Tree - Muthatari In-Depth Interview