LINKAGES BETWEEN INTEGRATED SOIL FERTILITY MANAGEMENT TECHNOLOGIES AND MARKETING OF SMALLHOLDER PRODUCE IN MERU SOUTH AND MBEERE DISTRICTS, KENYA

Cheroben Chemtai Sarah
(N50/10236/06)

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DECLARATION

Candidate's declaration

This thesis is my original work and has not been presented for award of a degree in any other university or for any other purpose.

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Cheroben Chemtai Sarah (N50/10236/06) Date

Declaration by supervisors

This work has been submitted with our approval as supervisors

__________________________ __________________________

Prof. James B. Kung'u Date
Associate Professor
Department of Environmental Sciences
School of Environmental Studies
Kenyatta University

__________________________ __________________________

Dr. Theresa C. Aloo Date
Senior Lecturer
Department of Environmental Sciences
School of Environmental Studies
Kenyatta University

DEDICATION

To my parents Mr and Mrs Cheroben, My Husband Mr. Makan and daughter Tamnai Makan.

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The main inspiration for this study is God to whom I am grateful for all that I am. I am most indebted to my supervisors Prof. James B. Kung'u and Dr. Theresa C. Aloo for their inspiration, support and supervision throughout this research study. I also wish to express my gratitude to Dr. Samwel Wambugu for his insight and constructive criticism during proposal writing of this research.

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LIST OF ABBREVIATIONS AND ACRYNYMS

AGOA- African Growth and Opportunity Act

FAO- Food and Agriculture Organization

GDP-Gross Domestic Product

GOK- Republic of Kenya

ISFM- Integrated Soil Fertility Management

K- Potassium

LDCs- Least Developed Countries

MATF- Maendeleo Agricultural Technology Fund

MDGs- Millennium Development Goals

NEPAD- New Partnership for Africa Development

N- Nitrogen

P- Phosphorus

SSA- Sub-Saharan Africa

SSPS- Statistical Package for Social Sciences

UM- Upper Midland

LM – Lower Midland

ABSTRACT

Land degradation and declining soil fertility are increasingly being viewed as critical problems affecting agricultural productivity and human welfare in tropical Africa. It is then imperative that improving soil fertility is key entry point for achieving food security, reducing poverty and preserving the environment for smallholder farms in Africa. However, due to high costs of inorganic fertilizers, tackling soil fertility issues thus requires a holistic approach that integrates biological and social elements. Linking farmers to markets and adding value to raw products have great potential for improving the incomes of smallholder farmers. This study was conducted in Meru South and Mbeere districts of Kenya which are located in the central highlands of Kenya from May to November 2008. The study involved a survey of 150 farmers who had access to Integrated Soil Fertility Management technologies (ISFM). Purposive sampling method was employed. Simple random sampling was used in selecting the farmers from the four catchment areas of Murugi, Mukuuni, Kirege locations in Meru South district and Machang'a location in Mbeere district. A total of 150 farmers were interviewed during the survey. Self administered questionnaires were used to collect data from the sampled farmers. Information on the type of agricultural crops cultivated, area under cultivation and inputs applied were gathered. Information on marketing dynamics among smallholder farmers in the study area was also collected. An analysis of the ISFM technologies introduced and the ones currently in use by farmers was done. Market analysis of smallholder produce was conducted with a focus on market types, marketing channels and identification of constraints to crop marketing. The data were correlated in a bid to establish whether a relationship exists between crop production using ISFM technologies and marketing of smallholder produce. Tables, figures and other descriptive methods were used in data analysis such as the Chi-Square and correlation analysis. The results revealed that sampled farmers were aware of the benefits accrued from application of the ISFM technologies and other extension services. However, these technologies were not continuously being practiced among smallholder farmers due to their inability to obtain good returns from crops. They indicated that the main problem facing the wide practice of ISFM innovations was poor market returns for their produce caused by low prices offered especially by brokers. This is despite the fact that 66% of the farmers in both study sites obtained their main income from sale of crops. In order to improve the returns that the farmers get from their application of ISFM technologies, this study recommends that project developers and policy makers on soil fertility should recognize the need to equip smallholder farmers with not only practical soil fertility replenishing skills but also on marketing skills. Farmers should be assisted in identifying suitable agro-enterprises and in formation of marketing groups. This will not only give them advantage of economies of scale but also boost their bargaining power while selling their produce. The study recommends further research to be conducted among small, medium and large scale farmers to provide a basis for comparisons on the aspects of natural resource management and marketing.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Achieving the Millennium Development Goals (MDGs) is at the heart of the global agenda. The goals embody the world's aspirations to eliminate desperate hunger and poverty, ensure decent health, enable universal education and elevate the status of women, while conserving and regenerating the global environment. Attaining these goals is the greatest challenge of our generation. Their accomplishment will bring benefits to everyone, including greater economic abundance, peace, and security to all people on the globe (Garrity *et al.*, 2006). One way of achieving these goals and aspiration is through agroforestry research and development. Agroforestry is practiced by millions of farmers and has been a feature of agriculture for millennia. It encompasses a wide range of working trees that are grown on farms and in rural landscapes, and includes the generation of science –based tree enterprise opportunities that can be important in the future. Among these are: fertilizer trees for land regeneration, soil health and food security (Garrity *et al*., 2006).

Land degradation and soil nutrient depletion have become serious threats to agricultural productivity in sub- Saharan Africa. Most arable lands have been affected by degradation thereby reducing agricultural productivity, which in turn results in poor economic growth of countries (Bekele, 2003). Ultimately this results in abject poverty and high incidences of food insecurity among the population that depend on agriculture for livelihood. The continued threat to land resources is exacerbated by the need to reduce poverty and poor farming practices, especially among smallholder farmers (Chinagwa, 2006). It is estimated that an average of 660 kg of nitrogen (N) /ha, 75 kg of phosphorus (P)/ha and 450 kg of potassium (K)/ha have been lost during the last 30 years from around 200 million ha of cultivated land in 37 countries in sub-Saharan Africa (SSA) (Stoorvogel *et al.,* 1993). This is mostly due to continuous cultivation of land without replenishing the soils with the required nutrients. The estimated value of such losses averages US$4 billion per year (Drechsel P and. Gyyiele, 1999).

Agriculture remains the backbone of the Kenyan economy and it is the single most important sector in the economy, contributing approximately 25% of the GDP, and employing 75% of the national labour force (Republic of Kenya, 2005). Over 80% of the Kenyan population live in the rural areas and derive their livelihoods, directly or indirectly from agriculture. About 80% of the total agricultural output in Kenya comes from small-scale producers (Odhiambo, 1998). It is then imperative that improving soil fertility is a key entry point for achieving food security, reducing poverty and preserving the environment. However, it is important to note that simply getting farmers to produce more is not the answer to the problem of increasing rural incomes and enhancing food security.

Although most of the changes in agricultural and food markets are taking place in the developed countries, they have far-reaching implications for agricultural development efforts in developing countries (Kirsten and Sartorius, 2002). It should be noted that the majority of the rural poor are smallholder farmers. According to Kherralah *et al.*2002, the evidence on the impact of agricultural market reforms on poverty is mixed.

There is evidence that such liberalization, privatization and tax reforms in fact created serious instability, inequality and inefficiency, because they were carried out without the regulatory and legal frameworks, and government rules and structures, that make banking systems,corporate governance , and tax collection work effectively in advanced industrial countries (Azfar,2002). The combined effects of liberalization of agricultural markets and globalization have generally increased economic differentiation among communities and households. By virtue of their location, asset base and levels of organization, some communities-and some households within communities- have succeeded in responding to new market opportunities, and have been able to increase their incomes, in some cases substantially (IFAD, 2003). With the withdrawal of the state from agricultural marketing, a new-and highly uncertain environment has been created, in which prices, whether for selling produce or purchasing inputs are now largely negotiated. New commercial relations must be struck with a myriad of suppliers and buyers. For some farmers, this has created major new opportunities; for others, it has created major problems.

Smallholder farmers are ill equipped to benefit from the new market environment. They face enormous constraints in physically accessing markets. They also lack information about markets, business and negotiating experiences and a collective organization to give them the power they need to interact on equal terms with other-generally larger, stronger market intermediaries. The result is poor terms of exchange and little influence over they are offered (Heinemann, 2002).

Hence, there is need to pay attention to ways of promoting more of business orientations among farmers by encouraging them to relate their production more closely to market demand in order to supply markets effectively (FAO, 2005). Consequently, linking farmers to markets and adding value to raw products have great potential for improving the incomes. Facilitating the scaling up of agroforestry practices ensures that the initial intention of employing agroforestry to improve soil fertility is sustained (Dewees and Scherr, 1996). Integrating smallholder farmers into commodity chains must be a priority and only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity (Omamo, 2005).

It is against this background that this research focused on the interrelationship that exists between soil fertility improving technologies and marketing of increased yields due to agroforestry soil fertility enhancement. The information generated should provide a base for environmental policy makers and project developers to take into account the variability that exists among farmers and hence come up with appropriate interventions that will suit them, ensuring sustainability of the ISFM technologies and ultimate management of the natural resource.

1.2 Problem statement

Low soil fertility is one of the biophysical constraints to increasing agriculture productivity (Chinagwa, 2006). Improving soil fertility levels has become an important issue in development agendas because of its linkage to food insecurity and economic well being of the population. Given the acute poverty and limited access to mineral fertilizers, a promising approach has to be one that integrates organic and inorganic fertilizers

(Franzel, 1999). ISFM practices have been found beneficial in the management of soil health. Agroforestry which is one of ISFM practices when build on local indigenous knowledge will offer substantial benefits to households and the environment (Cooper *et al.*, 1996; Franzel and Scherr, 2002; Place *et al*., 2002). Drawing on a range of expertise, Cooper and Denning (2000) identified market options as one of the 10 essential elements of scaling up agroforestry innovations. Linking farmers to markets and adding value to raw products have great potential for improving the incomes of smallholders and facilitating the scaling up of agroforestry practices (Dewees and Scherr, 1996) and therefore ensuring that the initial intention of employing agroforestry to improve soil fertility is sustained. Dewees and Scherr (1996) acknowledge that the uptake of the new practices depends on the availability of markets for the final products. To echo their views, Omamo, (2005) reports that integrating smallholder farmers into commodity chains must be the priority because that only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity.

Although ISFM technologies were introduced in Meru South and Mbeere districts more than a decade ago, smallholder farmers are being confronted with the challenge of finding markets for their produce. This has far reaching implications on the sustainability of adopted agroforestry innovations. It is against this challenge that this study was carried out to find out the linkage between ISFM technologiese and the marketing of the smallholder produce. This is likely to ensure that the adopted agroforestry innovations are sustained on a scale that has meaningful economic, social and environmental services.

1.3 Research Questions

In order to achieve the objectives of the study, the following research questions guided the study:

1. Which ISFM technologies have been adopted by smallholder farmers?
2. How do smallholder farmers market their crop produce?
3. How do ISFM technologies link to the marketing of smallholder produce?

1.4 Objectives of the Study

The general objective of the study was to find out the linkage between sustainability of ISFM technologies and marketing of smallholder produce. Specific objectives were:

1. To identify ISFM technologies among smallholder farmers
2. To evaluate marketing of smallholder crop produce
3. To determine the linkage between the adopted ISFM technologies and marketing of smallholder produce.

1.5 Rationale of the Study

The most universally recognized role played by trees in agricultural systems is that of soil conservation and replenishment of soil fertility (Sanchez *et al.*, 1997). The degradation of soil fertility specifically the capacity of the soil to support agricultural production has been identified as one of the main causes of Africa's agricultural failure (Buresh *et al.*, 1997). The soil fertility problem remains intractable because of the failure to deal with the issues in a sufficiently holistic way (TSBF/ICRAF, 2002). Tackling soil fertility issues thus requires a long-term perspective and a holistic approach that integrates biological and social elements (Swift and Palm, 2000). As expressed in the African

Highlands Initiatives, integrated resource management embodies the principle for improving livelihoods (Stroud and Khandelwal, 2003). One way of doing this is through marketing of smallholder produce. In their 1994 paper, Scherr and Hazell provided six main reasons why smallholder farmers may not invest or adopt natural resource management technologies. One of them is lack of incentives to invest in a resource that farmers may have access to make investments in natural resources but the payoff from doing so appears unattractive e.g. where output markets are lacking, farmers are discouraged from investing or adopting beneficial ISFM technologies. Even where markets exist, in many areas of rural Africa the ratio of farm gate input costs to output prices is so high and it discourage all but the minimum of investment (Ibid). Integrating smallholder farmers into commodity chains must be the priority. Only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity (Omamo, 2005). Hence, this research tried to relate ISFM technologies to marketing of smallholder produce.

1.6 Conceptual framework

Soil fertility degradation has been described as one of the major constraints to food security and income generation in developing countries. Despite proposals for a diversity of solutions and the investment of time and resources by a wide range of institutions it continues to prove a substantially pervasive problem. The rural poor are often trapped in a vicious poverty cycle between land degradation, fuelled by the lack of relevant knowledge or appropriate technologies to generate adequate income and opportunities to overcome land degradation. Intensification and diversification of agricultural production on smallholdings is required to meet the food and income needs of the poor, and this cannot occur without investment in soil fertility. Investing in soil fertility management is necessary to help households mitigate many of the characteristics of poverty, for example by improving the quantity and quality of food, income, and resilience of soil productive capacity to environmental change.

The integrated soil fertility management (ISFM) is a holistic approach to soil fertility research that embraces the full range of driving factors and consequences of soil degradation — biological, physical, chemical, social, economic and political. There is a strong emphasis in ISFM research on understanding and seeking to manage the processes that contribute to changes in soil fertility. The emergence of this paradigm, very closely related to the wider concepts of integrated natural resource management (INRM), represents a significant step beyond the earlier, narrower, nutrient replenishment approach to soil fertility enhancement. Adopting an integrated approach that will combine organic and inorganic fertilizers will result to improved soil fertility and soil conservation and increased crop yields.

Research on natural resource management has been criticized for not addressing the real needs of rural people and hence has often been judged irrelevant. In the march to generate solutions to farmers' problems, research has generated a wide variety of technologies, such as fertilizers, improved legume germplasm and crop rotations. ISFM arose because of the recognition that addressing the interactions between components (e.g. water, pests and soils) is as important as dealing with the components themselves. However, improving the natural resource base without addressing issues of marketing and income generation (e.g. the resource-to-consumption logic) seems sterile and is often the reason for a lack of adoption of improved farming practices (CIAT,2005). However, in order to ensure that farmers experience the direct benefit of adopting ISFM technologies, it is important that the increasing yields find market. This will result to smallholder farmers investing in the introduced ISFM technologies, farmers accruing income from sale of their produce and ensuring food security, that is; farmers can buy food that they do not cultivate as show in Figure 1 below.

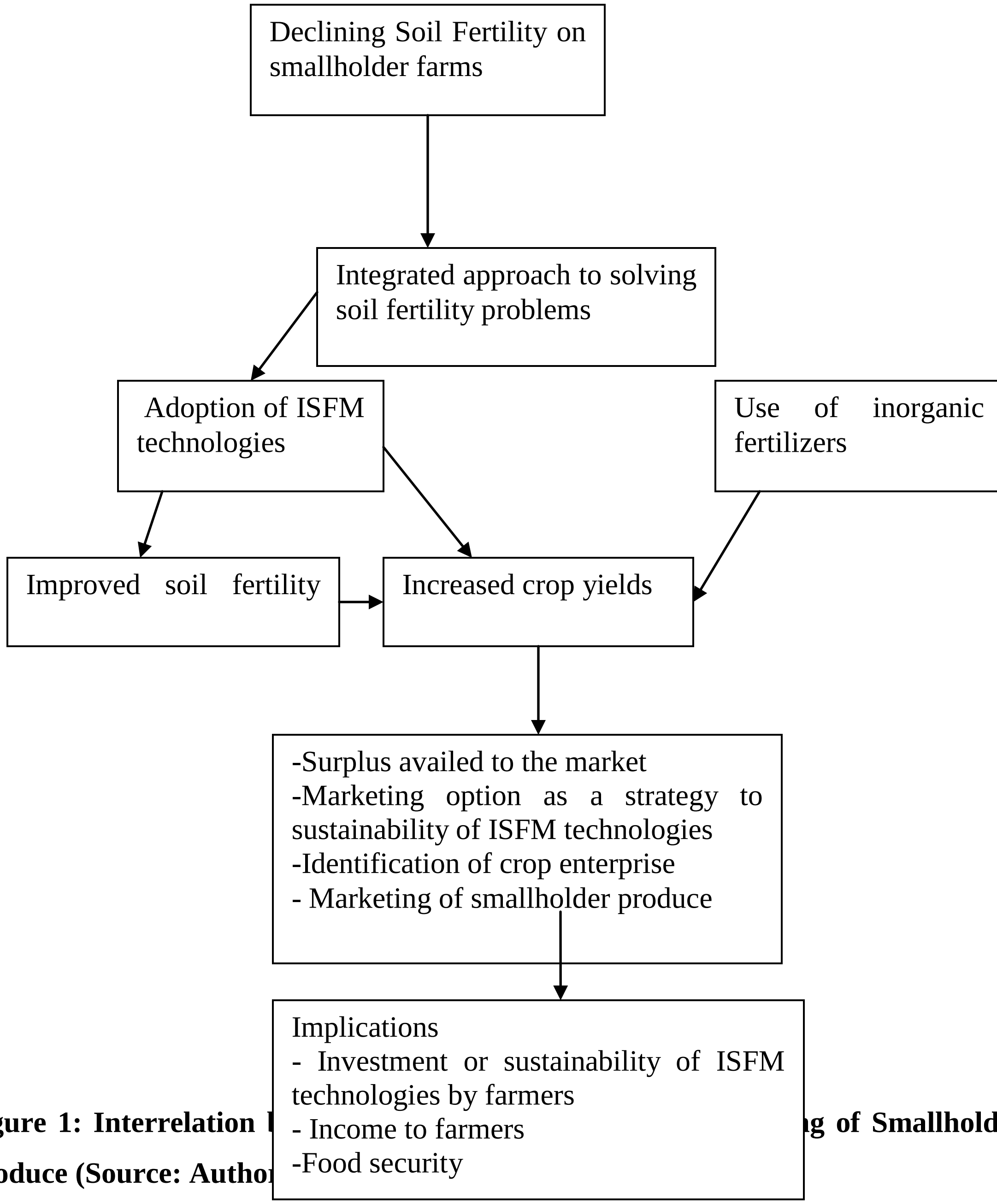


Figure 1: Interrelation b… …ng of Smallholder Produce (Source: Autho…

1.7. Operational Definitions of Terms and Concepts

Agricultural potential: refers to the ability of the land to support rainfed agriculture

Agro-enterprise: refers to a business venture, typically small scale, that can be undertaken either on-farm, or a service that can be used to support other businesses

Demand: A schedule of quantities of goods or services the consumer is willing and able to buy at a given time and place at different price level

Food security: a situation that exists when all people , at all times have physical, social and economic access to sufficient , safe and nutritious food that meets dietary needs and food preferences for active and healthy life

Market: is the overall demand for a product at a given place and time, under specific standards and conditions. It can be categorized by the number of sellers and the number of buyers of a commodity.

Marketing: is the process of identifying, stimulating, and facilitating and satisfying customers demands. It requires the collection and analysis of information to identify markets and learn what consumers need and want. Marketing also involves the physical delivery of goods to the customer. It also refers to the process of bringing sellers and buyers together for the purpose of exchanging title to goods and services.

Marketing channel: sequence of enterprises and markets by which produce is moved from producer to consumer

Marketing information is that data that can help those involved in production and sales identify and meet client needs.

Supply: is a schedule of the quantities of a good or a service producers are willing and able to sell at a given time at different prices levels in a given market

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

One of the challenges facing Kenya today is the production of adequate food to feed the rapidly growing population and in particular, the inhabitants of the densely populated highlands of central Kenya with over 500 persons per km^2 (Republic of Kenya, 1994). Smallholder farmers in most parts of the country are experiencing declining food production as a result of soil fertility decline due to continuous cropping with little nutrient replenishment (Ikombo, 1984). ISFM has emerged as an alternative to improving the soil nutrient capital (Waswa, 2005). This section will discuss the various approaches to solving problems of soil fertility, the role of smallholder sector in agricultural production, marketed production and identifying and closing of gaps.

2.2 Approaches to solving the declining Soil Fertility

Soil fertility largely depends on soil organic matter content, which besides supplying nutrients, ensures good physical conditions necessary for water infiltration, supply of soil moisture, aeration and plant root development (Chinagwa, 2006) and influencing essential soil-based environmental services such as water use efficiency, carbon sequestration and clean water supply (Vanlauwe, 2004). Although crop yields are not directly correlated to the amount of organic matter in the soil, the lack of it will cause the breakdown of soil structure, increased runoff, accelerate erosion and increase soil compaction that will prevent the development of a healthy root system and cause a reduction in nutrient and water availability to the plant (FAO, 1999). Low crop yields are no longer attributed just to lack of rains, but also to declining soil fertility.

2.2.1 Integrated Soil Fertility Management Technologies

The integrated soil fertility management (ISFM) is a holistic approach to soil fertility research that embraces the full range of driving factors and consequences of soil degradation such as biological, physical, chemical, social, economic and political (Kimani *et al.,* 2003). There is a strong emphasis in ISFM research on understanding and seeking to manage the processes that contribute to changes in soil fertility. The emergence of this paradigm, very closely related to the wider concepts of integrated natural resource management (INRM), represents a significant step beyond the earlier, narrower, nutrient replenishment approach to soil fertility enhancement.

Soil fertility degradation has been described as one of the major constraints to food security and income generation in developing countries. Despite proposals for a diversity of solutions and the investment of time and resources by a wide range of institutions it continues to prove a substantially pervasive problem. The rural poor are often trapped in a vicious poverty cycle between land degradation, fuelled by the lack of relevant knowledge or appropriate technologies to generate adequate income and opportunities to overcome land degradation. Intensification and diversification of agricultural production on smallholdings is required to meet the food and income needs of the poor, and this cannot occur without investment in soil fertility. Investing in soil fertility management is necessary to help households mitigate many of the characteristics of poverty, for example by improving the quantity and quality of food, income, and resilience of soil productive capacity to environmental change.

Research on natural resource management has been criticized for not addressing the real needs of rural people and hence has often been judged irrelevant. In the march to generate solutions to farmers' problems, research has generated a wide variety of technologies, such as fertilizers, improved germplasm and cropping systems. ISFM arose because of the recognition that addressing the interactions between components (e.g. water, pests and soils) is as important as dealing with the components themselves. However, improving the natural resource base without addressing issues of marketing and income generation (e.g. the resource-to-consumption logic) seems sterile and is often the reason for a lack of adoption of improved farming practices (TSBF-CIAT, 2005)

Improving soil fertility is then a key entry point for achieving food security, reducing poverty and preserving the environment for smallholder farms in SSA (Garrity *et al.*, 2006). Given the high cost of inorganic fertilizers, an integrated approach will be one that combines promising agroforestry technologies (organic) and inorganic fertilizers (Ibid). Organic fertilizers include the use of improved fallows of leguminous trees, shrubs, herbaceous legumes and biomass transfer to improve soil conditions. Agroforestry trees have great potential for improving soil fertility in areas dominated by Nitrogen deficiency (Chinagwa, 2006). In areas where P is also a major limiting factor, inorganic sources of P should be used. Besides improving soil fertility, agroforestry technologies provide benefits such as fuel wood, poles, fodder, and help reduce soil erosion.

2.2.1.1 Biomass transfer

Existing hedges on farm borders are another source of organic nutrients for biomass transfer. More than 10 species with potential for this purpose have been screened in western Kenya (Niang et al. 1996), and most promising of all is *Tithonia diversifolia* of the family Asteraceae (tithonia). Although it is not a legume, the fresh leaf biomass of tithonia has levels of N as high as those found in many N-fixing legumes. The common shrub is also rich in P and K: the fresh leaves contain 3.5% N, 0.3% P and 3.8% K. the leaf biomass decomposes rapidly with a half –life of about one week especially during the rainy season (Gachengo, 1996). Many field studies report that the application of tithonia biomass results in higher crop yields than application of inorganic fertilizers and it has longer residual effects (Gachengo, 1996; Jama *et al.*, 2000). Part of the yield benefits associated with tithonia could be due to increased availability of nutrients. Phosphorus release from *Tithonia* fresh leaf biomass is rapid, and the supply of plant –available P from tithonia can be at least as effective as an equivalent amount of soluble fertilizers (Garrity *et al.,* 2006).

2.2.1.2 Improved fallows

Planted fallows of leguminous trees or shrubs can biologically fix considerable amounts of N-for example, between 60-80 kg/ha in above ground biomass (Gathumbi, 2000). Nitrogen that accumulates in the above-ground biomass of planted tree fallows is returned to the soil upon clearing, the fallow biomass is incorporated into the soil for subsequent cropping. Additionally, fallows increase the amount of labile fractions of organic soil matter, which supply nutrients to crops following fallows (Barrios *et al*., 1997). They can also contribute to improving soil structure, build up of soil organic matter and its carbon (C) stocks, thus contributing to C sequestration (Barrios *et al*., 1997).

The choice of which species to plant in the fallow period is influenced by both biophysical and socioeconomic conditions. The ideal tree species is typically fast-growing, N-fixing and efficient at nutrient capture and cycling. Examples of promising species include *Crotaria grahamiana, Tephrosa vogelii, Caunas Cajan (pigeon pea) and Sesbania Sesban.* Coppicing species can also be used, *and Gliricidia sepium* and *Calliandra calothyrsus* are becoming increasingly more popular with farmers in Kenya, Malawi and Zambia because they are perennial and, unlike the non-coppicing species, there are no costs involved in replanting them once they are cut back.

2.2.1.3 Livestock manure use

For smallholder farms, farm yard manure is a major source of nutrients. However, quality is poor and quantities available are often low, especially in densely populated regions like western Kenya where farmers keep few animals (Kihanda and Gichuru, 1999). Quality can be improved through better management, including feeding nutrient-rich tree fodder to cattle. Manure from livestock fed with *Calliandra* fodder can be especially high in P, for example, as demonstrated through studies in western Kenya (Jamal *et al.,* 1997). Application of this manure at rates typically used by farmers in the area more than doubled maize yields in P- deficient soils, and effects were even greater when it was spot applied (placed in the planting hole) instead of broadcast.

2.2.2 Use of inorganic fertilizers

The use of inorganic fertilizers as an option for improving soil fertility and productivity, has immediate results, but is unaffordable for most farmers. In spite of the growing awareness of low cost soil fertility technologies, the rate of adoption and continued use of these technologies remain limited (Chinagwa, 2006)

2.3 The role of the smallholder sector agricultural production

Review of the evidence indicates that concentrating agricultural strategy on intensifying smallholder production offers the best possibilities for increasing output and domestic value addition, while meeting the central problems of increasing food and export crop production, and closing the foreign exchange gap (Muturi, 2001). First, smallholders are the major productive sector in the agricultural economy producing half of the food supplies Since much of the smallholder food production is self –consumed or locally traded, statistics on marketed production do not reflect enormous important role which smallholders plays in assuring national food supplies. In Kenya, smallholder produce about 70% of the total national supply of maize, 50% marketed maize, 45% of sugarcane, major amounts of milk and meat and nearly all rice and pulses (World Bank, 1986). Any effort to achieve domestic food self-sufficiency will require the close cooperation of smallholders. Secondly, smallholders are also major producers of export crops, supplying

64% of coffee and 40% of tea exports in addition to almost all yields and intensifying production is much greater on smallholding than on large farms in Kenya (Ibid). Because of the important role of small farms in the total structure of production (comprising 61% of total land farmed area), intensification of smallholder production could make a substantial contribution to agricultural growth without increasing total area under production.

2.3.1 Marketed production

The smallholder sector dominates agricultural production in Kenya. In spite of their small sizes, smallholders account for over 75% of total production and approximately 70% of marketed production. Many smallholder farmers in low-income countries are excluded from market for agricultural products and inputs because the costs and risks of market participation are simply too high (World Bank, 2003). In addition, Heinemann, 2002 noted that rural people in Africa, especially the poor, often gives reason that they cannot improve their living standards due to difficulties of accessing markets where they can obtain agricultural inputs and consumer goods and sell the produce that they grow. A major reason why even those farmers who can produce a surplus remain trapped in the poverty cycle is lack of access to profitable markets. All too often farmers are forced to sell to the buyer of convenience at whatever price that buyer dictates (IITA, 2001). Integrating smallholder farmers into commodity chains must be the priority. Only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity (Omamo, 2005).

2.4 The resource-to-consumption (R-to-C) concept

The R-to-C concept aims to alleviate poverty in rural communities by taking a holistic approach with communities to their empowerment, development of rural agro-enterprises and management of natural resources, while systematically gaining detailed insights and lessons that should be useful to many similar actors elsewhere. The concept extends the commodity chain to include investment in natural resource management, and specifically links natural resource management (NRM) to market opportunities. It focuses on increasing household food security and producing crops that have an identified market opportunity. This differs from the conventional approach of trying to find markets for excess production at harvest time when commodity prices are at their lowest. More specifically, it links farmer participatory research, market opportunity identification, and development of technologies for integrated soil and nutrient management, with a focus on women and the poor (Delve and Roothaert, 2003). The steps in the R-to-C framework are: participatory diagnosis with the community, with strong emphasis on gender and stakeholder analysis to identify differentiation of roles and perceptions, formation of farmer research group and market research group, and building their capacity to participate actively in selecting, testing and evaluating marketing strategies and technology options, participatory market analysis to identify market opportunities for competitive products that will increase farm income and employment and prioritization of options for addressing household food consumption and agro-enterprise options through feasibility studies and cost benefit analysis. Other important steps include, planning and implementation of experimentation and marketing strategies with farmer research and market research groups, development of community enterprise development and strengthening community agro-enterprise development, feedback of results to the community and R&D research, and identification of further research questions and participatory, monitoring and evaluation, and learning to derive lessons and impacts, and scaling-up and out of participatory research results and of community enterprise development process (Delve and Roothaert, 2003).

2.5 Identifying and closing Gaps in Knowledge

Land degradation and declining soil fertility are increasingly being ` as critical problems affecting agricultural productivity and human welfare in tropical Africa. It is then imperative that improving soil fertility is key entry point for achieving food security, reducing poverty and preserving the environment for smallholder farms in SSA. However, due to high costs of inorganic fertilizers, tackling soil fertility issues thus requires a long-term perspective and a holistic approach that integrates biological and social elements. Linking farmers to markets and adding value to raw products have great potential for improving the incomes of smallholders and facilitating up the scaling up process of agroforestry practices. Dewees and Scherr (1996) acknowledged that the uptake of the new practices depends on the availability of markets for the final products. To echo their views, Omamo, (2005) reported that integrating smallholder farmers into commodity chains must be the priority. Only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The study was carried out in Meru South and Mbeere districts located in the Central highlands of Kenya. This study builds on an earlier project on “Participatory Scaling-up of Soil Nutrient Management Technologies for Increased Crop Yields in Smallholder Farms of Central Highlands of Kenya (MATF 026)” was initiated in February 2004. The project’s main objective was to scale-up locally available organic inputs that are effective in improving soil fertility and in increasing maize yields. Decline in food production as a result of continuous cultivation without adequate addition of external inputs had been identified as a major concern in the areas. To address this concern a Rockefeller Foundation funded (FORUM) project, which run from February 2000 to January 2003, was initiated with its major goal of developing technologies capable of increasing food production in the smallholder farms in the region. Major findings from this project indicated that locally available organic inputs like tithonia are effective in improving soil fertility and in increasing maize yields. Indeed farmers were interested in trying out these promising technologies and by 2002/2003 short rain season, a total of 206 farmers were already trying some of these technologies in their farms. There was therefore a realized need of scaling up these promising technologies to more farmers and hence the inception of FARM Africa project on “Participatory Scaling-up of Soil Nutrient Management Technologies for Increased Crop Yields in Smallholder Farms of Central Highlands of

Kenya (MATF 026)".The target of this project was to reach 5,000 farmers in two years. However, by the year 2006, the project had not met its target of 5,000 farmers instead some of the farmers who were participating in the project had pulled out instead. The motivation of this study was therefore to try and find out why such trend in a ones receptive project to the farmers. It was found out that marketing of smallholder produce was one factor that had led to abandonment of these promising technologies hence the study tried to look at the linkage between these technologies and marketing of smallholder produce. From the findings appropriate recommendations were made to project developers and other policy makers.

This section also included nature and sources of data, methods of data collection, the sampling design used and data analysis and presentation.

3.2 Description of the areas of study

A brief description on Meru South and Mbeere districts was provided. The information included the agroecological zones the districts are found, the rainfall pattern, type of soils found in each area, crops cultivated and animals kept.

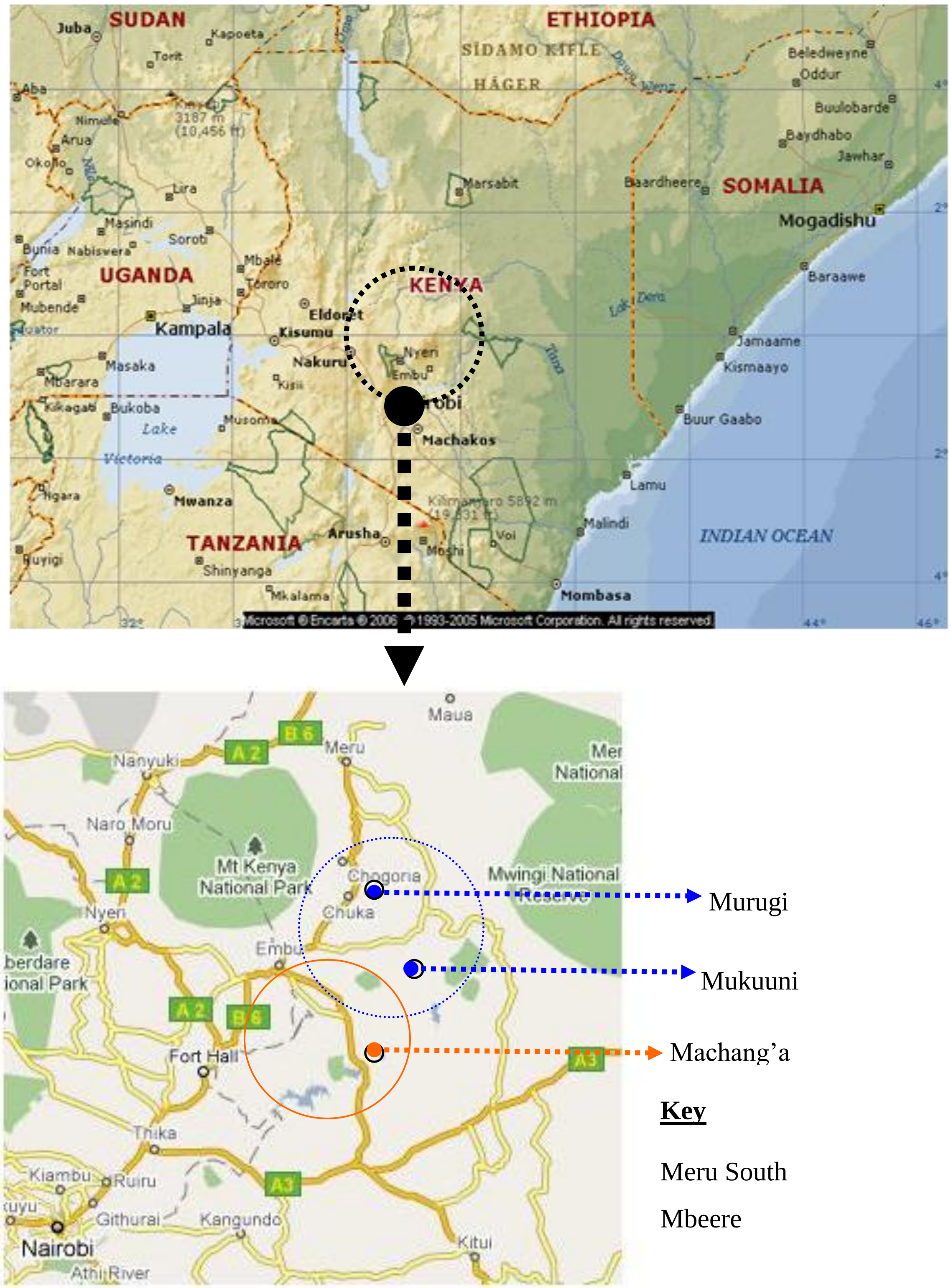
3.2.1 Meru South District

Meru South is in the upper midland zones two and three (UM2-UM3) (Jaetzold and Schmidt, 1983). The area lies on the eastern slopes of Mt. Kenya at an altitude of approximately 1500 m above sea level (a.s.l.) with an annual mean temperature of 20° C. It has an annual rainfall ranging from 1200 to 1400 mm which is bimodal with long rains (LR) occurring from March to June and the short rains (SR) from October to December. The soils are deep, well drained, weathered Humic Nitisols (commonly called red Kikuyu loams) with moderate to high inherent fertility (Jaetzold and Schmidt, 1983). A wide variety of crops and cropping systems as well as and livestock are found within individual farm holdings. Coffee (Coffea arabica) and tea (Camellia sinensis) are the major cash crops, while maize (Zea mays) and beans (Phaselous vulgaris) are the main food crops in the area. Other food crops include Irish potatoes, cassava, bananas, sweet potatoes, and various fruits and vegetables. Cattle, sheep, goats and poultry are the most common livestock kept in the area.

3.2.2 Mbeere District

Mbeere district lies between latitude $0^o20'$ and $0^o 50'$ South and longitude $37^o 16'$ and $37^o 56'$ East. The district is classified as a marginal cotton zone (LM4) and has two rain seasons with the long rains falling between March and June while short rains are experienced from October to December. The rainfall is however not very reliable and it ranges between 640-1100 mm per year (Republic of Kenya, 1997). Soils are generally sandy-loam (Chromic cambisol), shallow (about 1 m deep) and are generally low in organic matter (Jaetzold and Schmidt, 1983). Crops cultivated include cotton, green gram, pigeon peas. Livestock farming is also significant in the area.

Figure 2: Location Map showing Study sites in Meru south and Mbeere Districts-Kenya



3.3 Nature and sources of Data

Data were collected from primary and secondary sources. The primary data were generated from interview schedules, focused group discussions that were conducted on 45 farmers. Primary data will be obtained from smallholder farmers for example on type of crops and major agro-enterprises conducted on their farms, quantities of produce for household consumption and sales, type of soil fertility enhancing technologies, size of land allocated to preferred crop, socio-economic characteristics such as education level of the farmers, how they market their produce and constraints they encounter as they market their farm produce.

Secondary sources, on the other hand, entailed an explorative review of relevant literature. The aim of secondary data in this study is to complement the primary data collected. Relevant information on integrated soil fertility management technologies and smallholder produce marketing with a focus on marketing channels, market types, commercialization of these crops in the area, constraints to crop marketing, role of markets on ISFM technologies, geographical location of the area, map of the study area among others.

Secondary data collected involved reviewing literature from various libraries such was World Agroforestry Centre and Public universities libraries. Both published and unpublished reports were reviewed. This helped to unveil previous research efforts that are pertinent to this study.

3.4 Methods of Data Collection

Several methods were used in collecting data from both primary and secondary data sources. This process entailed conducting interview schedules; focused group discussions and review of documented information as discussed below;

3.4.1 Interviews schedules

Semi-structured interview schedules were used. It involved posing questions systematically along the expected answer to find out what the farmers encounter as they employ various soil enhancing technologies when cultivating their produce and also as try to orient their agricultural production to markets. Information captured using this approach included the type of crops and major agro-enterprises conducted on their farms, quantities of produce for household consumption and sales, type of soil fertility enhancing technologies, size of land allocated to preferred crop, socio-economic characteristics such as education level of the farmers, how these farmers market their produce and constraints they encounter as they market their farm produce.

The semi-structured interview schedules were administered to 150 respondents. The schedules generated both qualitative and quantitative data that was collected through face to face method, using closed ended questions.

3.4.2 Focus Group Discussions

Focused group discussion was used in this study. Subjects from each farmer group that was selected for the study shall have separate discussions. At any given time both male and female farmers shall participate and each discussion shall consist of 10-15 members (farmers selected, researcher and research assistant). The aim of focused group discussions is to aid in soliciting information from participants; also it helps in clarifications of certain issues of study.

In this study three focused group discussions were organized from the list of participants in interview schedules with 2FGD being held in Meru South and 1 FGD in Mbeere district. These groups discussed issues relating to crop production, type of ISFM technologies applied and marketing of smallholder produce. Each FGD consisted of about 15 farmers. The small groups were homogenous in nature that is all participants were smallholders and at least carrying out one or two crop production on their farms with application of ISFM technologies.

3.5 Sampling Design

The study employed non–probability sampling in the selection of the subjects to be used. Three out of five catchments that were practicing ISFM practices were selected from which respondents were randomly selected. These catchments were Murugi, Kirege and Machang'a. From each site chosen a sample size of 50 persons was interviewed meeting the requirements of having the sample size lowest limit not less than 30 people. In practice surveys and sampling are frequently used in small-scale research involving 30-250 cases and therefore this research is a small scale survey research which has taken into consideration time and financial factors likely to limit it (Mwanje, 2001).

3.5.1 Simple random sampling

Simple random sampling was used in the selection of individuals within the three catchments that were part of the study. A sample frame of 215 farmers in Mukuuni was used to select 50 farmers who took part in adoption of soil fertility enhancing technologies. In Murugi, a sample frame of 200 farmers was used to choose 50 farmers. In Machang'a a sample frame of 120 farmers was used to select additional 50 participants. In all, a list of farmers was obtained from an earlier project on soil fertility enhancing technologies and each name was allocated a corresponding number, those farmers whose names corresponded to randomly picked numbers were included in the sample. The procedures were then repeated until the required sample size was obtained for each of the above groups.

3.5.2 Purposive sampling

Purposive sampling allowed the use of cases that had the required information. The study concentrated on smallholder farmer groups that had participated in an earlier project on use of soil fertility enhancing technologies. These were Mucwa, Murugi, Mukuuni, Machang'a and Kirege. In this particular study Murugi and Mukuuni both in Meru South were selected since they had the highest number of participants in the project. Mbeere district had only Machang'a which formed part of the study (MATF, 2005)

3.6 Data Analysis and presentation

Collected data was analyzed quantitatively and qualitatively using descriptive statistics and other statistical tools and the Statistical analysis on socio-economic data was done using Statistical Package for Social Sciences (SPSS) specifically measures such as Chi-Square and Spearman's correlation analysis were used. Data was presented inform of percentages, tables and charts. This was then organized into related themes for discussion.

CHAPTER FOUR

RESULTS AND DISCUSSION

4. Introduction

This chapter presents the results from the survey data analyses and discussion of the findings of the study that examined the linkage between Integrated Soil Fertility Technologies (ISFM) and marketing of smallholder produce. The discussions are presented in sections addressing specific research questions and study objectives.

The bulk of the information originated from responses given by smallholder farmers during the field surveys and personal observations made during the field visits. It also includes secondary information gathered from literature. The chapter starts by describing general characteristics of the sampled households within the study areas, followed by crop production trends, inputs used (organic and inorganic) and marketing of smallholder produce.

4.1 Socioeconomic characteristics of households

The main characteristics of the sampled farm households in the two study areas were age of the farmers, level of education of the respondent, family size, farm size and area of land under cultivation.

4.1.1 Age of respondents in Meru South and Mbeere districts

The ages of respondents were grouped into four classes which were 21-30, 31-40, 41-50 and above 51 years (Table 4.1). Those respondents whose age was between 21 and 40 years were termed as young farmers while those above 40 years were regarded as old. In Meru South district, 40% of respondents were above 51 years old, 30% were between ages 41-50 years and 25% of respondents were in the age bracket of 31-40 years while 5% were between ages 21-30. Consequently, it was deduced in Meru South, 60% of those practicing farming are between ages 21-50 years, while those over 51 years constituted 40% of the respondents. Crop cultivation is therefore the main economic activity undertaken in the area and can be attributed to favourable climatic conditions in the area that support farming. Jaetzold and Schmidt, 1983 reports that the area lies on the eastern slopes of Mt. Kenya at an altitude of approximately 1500 m above sea level with an annual mean temperature of 20° C. It has an annual rainfall ranging from 1200 to 1400 mm which is bimodal, falling in two distinct seasons. The long rains (LR) occur from March to June, and the short rains (SR) from October to December. The soils are deep, well drained, weathered Humic Nitisols (commonly called red Kikuyu loams) with moderate to high inherent fertility.

In Mbeere district 12% of the respondents were between ages 21-30, 32% between ages 31-40 years and 32% between ages 41-50 years while 24% of those interviewed were over 51 years. About one half (52%) of farmers in this district aged between 21-50 years.

In general, 34.6% of the respondents were young (that is, ages 21-40) and 65.4% (> 40 years) were old. This could be due to land tenure system where old people own the land in African culture.

Table 4.1: Age of respondents in Meru South and Mbeere districts

Age	Meru South		Mbeere		Total	
(Years)	n	%	n	%	n	%
< 20	-	-	-	-	-	-
21-30	5	5	6	12	11	7.3
31-40	25	25	16	32	41	27.3
41-50	30	30	16	32	46	30.7
>51	40	40	12	24	52	34.7
Total	100	100	50	100	150	100

4.1.2 Education level of the respondents

Education level was grouped into primary, secondary, tertiary and no education. As shown in Table 4.2, 60% and 52% of farmers had primary education in Meru South and Mbeere respectively. 31% of the respondents in Meru South had secondary education while in Mbeere they constituted 34%. 5% had tertiary education in Meru South district and 8% in Mbeere district. Those who had not attended any formal education comprised of 4% and 6% in Meru South and Mbeere respectively.

Table 4.2: Education level of the respondents in Meru South and Mbeere districts

Education level	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Primary	60	60	26	52	86	57.3
Secondary	31	31	17	34	48	32.0
Tertiary	5	5	4	8	9	6.0
None	4	4	3	6	7	4.7
Total	100	100	50	100	150	100

Therefore, the results indicated that in both districts, a significant proportion (>60%) of smallholder farmers had primary or no education. This has led to a big proportion of the population absorbed in primary production sector (Republic of Kenya, 1997). For instance, in Mbeere district, a big proportion of the labour force is absorbed in the primary production sector that include both on-farm and off-farm activities such as fishing and quarrying (Republic of Kenya,1997). The results of this study agree with the findings of Cavendish (2001) and Wang'ombe (2004) who have reported that rural households have little formal education. In general, the high proportion of respondents 96% and 94% in Meru South and Mbeere districts respectively who had some form of formal education was found to be literate. The advantage therefore of having literate farmers imply that it is easy to disseminate extension services such as ISFM innovations in the study areas. Such farmers can also be trained on aspects like agro-enterprise selection and marketing strategies. This is in line with the findings of Muriuki (2005) who has reported that the basic education attained is a useful background to develop them to better entrepreneurs who will generate higher income from their main source of livelihood.

4.1.3: Family size for the respondents in Meru South and Mbeere districts

In Meru South, 3% of the respondents have a family size of less than three persons, 35% consisted of 3-5 members, 49% of the respondents comprised of between 6-8 persons while 13% of those interviewed had more than 8 people in their households. On the other hand, in Mbeere district, 6% of the respondents had less than 3 members, 36% had between 3-5 members, and 34% had 6-8 people per household while 24% had more than 8 members as shown in Table 4.3 below.

In both study areas, 62% and 54% of the respondents in Meru South and Mbeere districts respectively had six or more persons per household, implying that such households could source their farm labour from within. This would offset or lower the cost of labour in the farm and allocation of saved costs to other farm inputs such as seed and fertilizer acquisition. However this may not be the case because poverty level within the household is associated with the composition in the household. There were more households in Mbeere district who had more than eight members per household represented by 24% as compared to 13% in Meru South district. The high percent of households in Mbeere district could be attributed to high poverty levels among the residents which could be as a result of poor climatic condition experienced in the area.

Table 4.3: Family size for the respondents in Meru South and Mbeere districts

Family size (No. of persons)	Meru South		Mbeere		Total	
	n	%	n	%	n	%
< 3	3	3	3	6	6	4.0
3-5	35	35	18	36	53	35.3
6-8	49	49	17	34	66	44.0
>8	13	13	12	24	25	16.7
Total	100	100	50	100	150	100

In total, 44% of the respondents in the study areas had family size of 6-8 people, 35.3% with 3-5 persons, and 16.7% with over 8 people while 4% had members less than 3 persons per household. Therefore, all households in the study areas had dependents whose needs had to be met in one way or the other. These findings agree with those of Mwangi (2003) who has reported that the presence of dependants within the household is an influencing factor for the farmers to sell their produce because of the associated needs such as household needs like school fees and, hospital bills among others.

4.1.4: Land size of the respondents in Meru South and Mbeere districts

As shown in Table 4.4, farmers in Meru South and Mbeere districts owning land less than 1 acre constituted 21% and 4% respectively. Respondents with 1-2 acres of land were 36% in Meru South and 16% in Mbeere. Those with 2.1-5 acres were 23% in Meru South and 40% in Mbeere while those with more than 5 acres of land consisted of 20% and 40% in Meru South and Mbeere respectively. Majority of the respondents in Meru South (57%) had land sizes not more than 2 acres while majority of respondents (80%) in Mbeere district had land sizes more than 2 acres. The discrepancy on land size ownership by farmers between both districts could be attributed to the fact that Meru South is a highly productive area than Mbeere which is semi-arid with low population density. This has led to a high population density which has resulted to fragmentation of land to support the ever growing population. This is in line with Meru South district development plan 2002-2008, where it is noted that as the population of the district continues to grow, pressures on land continue to increase leading to further subdivisions of land into uneconomic units (Republic of Kenya, 2002).

Table 4.4: Land sizes of the respondents in Meru South and Mbeere districts

Farm size (acres)	Meru South		Mbeere		Total	
	n	%	n	%	n	%
< 1	21	21	2	4	23	15.3
1-2	36	36	8	16	44	29.3
2.1-5	23	23	20	40	43	28.7
>5	20	20	20	40	40	26.7
Total	100	100	50	100	150	100

4.1.5: Size of land under cultivation for the respondents in Meru South and Mbeere districts

Sixty nine percent of the respondents in Meru South had land under cultivation less than one acre (<1 acre), 25% had 1-2 acres of land while only 6% had more than two acresof land under cultivation as shown in Table 4.5. The findings agree with the Meru South district development plan of 2002-2008, that has reported that the average farm size in low potential area was 4ha while high potential was 0.7 ha (Republic of Kenya, 2002). On the other hand, in Mbeere district farmers with land less than one acre (<1 acre) constituted 6% while 26% had land under cultivation between 1-2 acres. Those with over

2 acres constituted 78%. This could be attributed to the fact that Mbeere district is a semi –arid area and the land is less populated as compared to Meru South district (Republic of Kenya,1997).

Table 4.5: Size of land under cultivation for the respondents in Meru South and Mbeere districts

Land size (acres)	Meru South		Mbeere		Total	
	n	%	n	%	n	%
< 1	69	69	3	6	72	48.0
1-2	25	25	13	26	38	25.3
>2	6	6	34	78	40	26.7
Total	100	100	50	100	150	100

4.2 Farming pattern

4.2.1 Crop cultivation in Meru South and Mbeere districts

All crops in the two study regions are grown under rain fed conditions. A significant feature of the farming in the two districts is extensive practice of mixed cropping which is growing more than one crop on the same piece of land. The dominance of mixed cropping is attributed to smallholdings of the land which forces the farmers to maximize the production of different crops from the same plot (Odhiambo, 1998). As shown in Table 4.6, in Meru South, coffee is cultivated by 65% of the respondents, bananas by 89%, maize by 99% and beans by 93%. In addition, tea is grown by 5% of the respondents while potatoes accounted for 10%. Vegetables (kales, cabbages) were reported by 15% of the respondents. In Mbeere district, it was found that most farmers preferred growing maize and beans (each accounting for 96% of the respondent), green grams (78%) and cow peas (58%). Other crops were found to be grown although by a small proportion of farmers included vegetables especially cabbage and kales (6%); coffee, finger millet and pawpaw accounted for 2% each. These findings showed that maize and beans were most preferred and cultivated crops in both districts irrespective of their agroecological zones. In addition to maize and beans, banana and coffee were important crops cash crops in Meru South while in Mbeere district green grams and cow peas played an important role in the livelihoods of households.

Table 4.6: Some of the common crops under cultivation in Meru South and Mbeere districts

Type of crop	Meru South		Mbeere	
	n	%	n	%
Coffee	65	65	1	2
Tea	5	5	-	-
Banana	89	89	1	2
Potatoes	10	10	-	-
Maize	99	99	48	96
Beans	93	93	48	96
Green grams	-	-	38	76
Cowpeas	-	-	29	58
Vegetable (kales/cabbage)	15	15	3	6
Finger millet	-	-	1	2
Pawpaw	-	-	1	2

Key
*****n- the total number of the respondents cultivating different crops does not equal the number of respondents interviewed i.e. in Meru South N=100, in Mbeere N= 50
* %- the percent do not sum up to 100% because farmers gave more than one response regarding different crops

The variation in the preferred type of crops grown by the farmers between the two districts was found to be highly influenced by the agro-ecological zones of the two study sites. Meru South was in the upper midland zones two and three (UM2-UM3) which receives high annual rainfall ranging from 1200 - 1400 mm, (Jaetzold and Schmidt, 1983) as compared to Mbeere district was a marginal cotton zone, that is lower midland four - LM4 (Republic of Kenya,1997) with unreliable rainfall pattern with frequent droughts.

4.2.2 Animal production in Meru South and Mbeere districts

Smallholder animal production is a typical scenario in most African agricultural systems (Odhiambo, 1998). Farmers in the study areas were found to practice mixed farming in which crop production takes place alongside animal husbandry. As shown in Table 4.7, all farmers in Meru South and Mbeere districts kept poultry while 40% and 88% of the respondents in Meru South and Mbeere districts kept cattle respectively. Fifty percent of the respondents in Meru South and 86% of the farmers in Mbeere kept goats while 56% and 70% of the household had sheep in Meru South and Mbeere districts respectively. Rearing of pigs was only in Meru South constituted only 1%. Muturi (2001) indicated that farmers engage in multiple cash generating enterprises to generate cash income from diverse sources which is aimed at reducing risks associated with single enterprise. This was evident in both districts in that despite heavy pressure on land in Meru South due to high population density, most households kept poultry together with one or two dairy cows, goats and sheep (Republic of Kenya, 2002).

Table 4.7: Some of the animals kept by farmers in Meru South and Mbeere districts

Type of animal	Meru South		Mbeere	
	*n	*%	*n	*%
Poultry	95	95	46	92
Cattle	40	40	44	88
Goats	50	50	43	86
Sheep	56	56	35	70
Pigs	1	1	1	2

Key

*****n- the total number of the respondents keeping livestock on their farms do not equal the number of respondents interviewed i.e. in Meru South N=100, in Mbeere N= 50 since farmers gave more than one response
* %- the percent do not sum up to 100% because farmers gave more than one response regarding different categories of livestock

In contrast, animal production in Mbeere district was characterized by cattle and shoats which were of local breed and poultry. The findings agrees with Republic of Kenya (1997) that reports that livestock production is another important activity undertaken by the residents of Mbeere district and is second to agriculture in intensity and importance.

The high number of farmers keeping livestock in Mbeere may be attributed to land size ownership and agroecology. More than 80% of farmers in Mbeere district had slightly larger farms of more than 2.1 acres as compared to 43% of farmers in Meru South (Table 4.4). In respect to agro-ecology, Meru South was in a high potential area that favours cultivation of crops while Mbeere district was in a semi-arid area favourable to (indigenous) livestock production. However, it should be noted that this study did not undertake an in-depth coverage on livestock during the survey but it concentrated only on crops. This is because in this study the role of ISFM technologies was emphasized on increasing crop yields being cultivated.

4.2.3 Household land allocation to specific crops in Meru South and Mbeere districts

Farm sizes and land use pattern varied greatly between and even within the two study sites owing to different agro-ecological and physical conditions. The differences in the average size of holdings lead to different land use patterns, with food crops, especially maize and beans dominating in the small holder farms (Odhiambo, 1998). The average land area (in acres) devoted to the production of the various crops is shown in Table 4.8.

Table 4.8: Household land in acres devoted to main crops in Meru South and Mbeere districts

Land size (acres)	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Bananas	21.4	12.8	-	-	21.4	5.8
Coffee	37.3	22.3	-	-	37.3	10.2
Maize	64.5	38.5	83.8	42.2	148.3	40.5
Beans	44.2	26.4	49.5	24.9	93.7	25.6
Green grams	-	-	34.6	17.4	34.6	9.5
Cowpeas	-	-	30.8	15.5	30.8	8.4
Total	167.4	100	198.7	100	366.1	100

As shown in Table 4.8, Maize and beans which were main crops in both districts were generally allocated bigger acreage of 40.5% for maize and 25.6% for beans of the total land area under crop cultivation. This can be attributed to the fact that maize and beans serves both as cash crop and food crops in both study sites hence their wide cultivation. The results of this study agree with the findings of Muturi, (2001), who reports that the proportion of farmers who grow a given crop and the mean household land area devoted to its production are measures of the relative importance of the crops. For instance, in Meru South, maize, beans and bananas were not only used as food but were also sold to provide cash needed to meet other household expenses. Coffee in Meru South was purely cultivated as a cash crop. A similar scenario was depicted in Mbeere district despite its relative preference on green grams and cowpeas over coffee and bananas in Meru south because of their difference in the agro-ecological zones.

4.3 Soil Fertility Enhancing Technologies

An in depth discussion on ISFM technologies is provided in this section, this is expected to capture the first objective which was to identify and analyze the ISFM technologies practiced by smallholder farmers in Meru South and Mbeere districts.

4.3.1 Integrated Soil Fertility Management technologies

The main soil fertility enhancing technologies used by farmers in Meru South were from organic and inorganic sources. They included the application of manure, tithonia and inorganic fertilizers and their combination which were manure plus inorganic fertilizer, tithonia plus manure and a combination of manure, inorganic fertilizer and tithonia (Table 4.9). More than 90% of farmers in both districts were found to be using ISFM technologies.

Table 4.9: Various ISFM technologies used by farmers in Meru South and Mbeere districts

Technology type	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Manure	16	16	29	58	45	30.0
Inorganic fertilizer	10	10	3	6	13	8.7
Manure+ Fertilizer	40	40	18	36	58	38.7
Tithonia	3	3	-	-	3	2.0
Manure + Tithonia	8	8	-	-	8	5.3
Tithonia ,Fertilizer +Manure	23	23	-	-	23	15.3
Total	100	100	50	100	150	100

Meru South Significance at $p\leq 0.00$ level (X2= 70.660; df = 6; $p\leq0.00$).
Mbeere significance at $p\leq 0.00$ level. (X2= 24.875; df = 2, $p\leq0.00$).

The results of chi-square (X2) indicate that the differences in the use of various soil fertility enhancing technologies among farmers in Meru South district were significant at $p\leq 0.00$ level. (X2= 70.660; df = 6; $p\leq0.00$). While for the farmers in Mbeere district, the results of chi-Square indicate that the difference in the use of soil fertility technologies were significant at $p\leq 0.00$ level. (X2= 24.875; df = 2; $p\leq0.00$). Farmers in both study areas used any technology that was accessible to them, since their sole purpose of applying such technologies was to increase their yields. Hence ISFM technologies do not automatically have an added advantage over other forms of technologies. Perhaps the need for ISFM developers to include commodity chains into their development agendas Inorganic fertilizers were found to be rarely used in both districts.

The low percent (8.7%) of farmers solely using inorganic fertilizer was due to its high cost which barred majority of smallholder farmers from using it. This made the farmers seek alternative means that are cheap and reliable for improving soil fertility. This result agree with that of Odhiambo (1998) who has reported that inorganic fertilizers are used in decreasing dosage as access to them become difficult.

In regards to the use of manure, most farmers (58%) the use of manure in Mbeere district preferred using manure as compared to 16% in Meru South. This is because manure is widely available in Mbeere district since more farmers keep more livestock than their counterparts in Meru South district (Table 4.7). This is largely due to the semi arid climate experienced in Mbeere district that favours livestock production over crop cultivation due to unreliable rainfall pattern resulting to frequent droughts. Despite manure application, farmers reported that the use of manure did not adequately increase their yields hence they considered it not the best option for increasing soil fertility. This could be attributed to the poor quality of the manure. Kihanda and Gichuru (1999) reports that although farm yard manure is a major source of nutrients, its quality is poor and quantities available are often low. The quality of manure can however be improved through better management, including feeding nutrient rich tree fodder to livestock. For instance, manure from livestock fed with *Calliandra* fodder can be especially high in P (Jamal *et al.*, 1997).

Tithonia as an option for soil fertility and productivity has not been widely adopted in the two study areas covered. The use of tithonia was found among farmers in Meru South, with 3% of the farmers using Tithonia alone. *Tithonia diversifolia* was however used in combination of either manure constituting 8% of those interviewed or with manure and fertilizer accounting for 23% of the total farmers in Meru South. Farmers using tithonia alone or in combination were of the opinion that it increased the fertility of the soil since it easily decomposes especially during rainy season thus releasing nutrients to the planted crops. These findings agree with Gachengo (1996) who reports that tithonia fresh leaf biomass has high levels of N and compared well with those found in many N-fixing legumes. The common shrub is also rich in P and K with fresh leaves containing 3.5% N, 0.3% P and 3.8% K. The leaf biomass decomposes rapidly with a half –life of about one week especially during the rainy season Gachengo (1996). In addition, many field studies report that the application of tithonia biomass results in higher crop yields than application of inorganic fertilizers and it has longer residual effects (Gachengo, 1996; Jama et al, 2000). Part of the yield benefits associated with tithonia could be due to increased availability of nutrients. Phosphorus release from *Tithonia* fresh leaf biomass is rapid, and the supply of plant –available P from tithonia can be at least as effective as an equivalent amount of soluble fertilizers (Garrity *et al*., 2006).

Further, the findings of this study reveal that farmers have tried different technologies depending on its availability with the aim of improving their soil fertility thus expecting enhanced soil fertility to have positive effects on their crop productivity. This is in line with the basic rationale behind ISFM. ISFM recognizes that the organic inputs generally have low nutrient contents, and large and often non-available amounts of organic fertilizer would be required to maintain soil fertility levels in each and every field.

Sustaining soil fertility and increasing productivity using organic resources alone is a losing battle. The opposite strategy: the sole use of inorganic fertilizers may lead to yield gains in the short term but may negatively influence soil fertility (such as acidification), and lead to declining yields in the long term. The best strategy to improve productivity and maintain soil fertility in sub-Saharan Africa can be found in a combination of both inorganic and organic fertilizers where the inorganic fertilizer provides most of the nutrients and the organic fertilizer increases soil organic matter status, soil structure, and buffering capacity of the soil in general.

Use of both inorganic and organic fertilizers has proven to result in synergy, improving efficiency of both nutrient and water use (Groot, 1998). There is need therefore to enhance greater awareness amongst farmers on the beneficial use of ISFM technologies. This is because unless measures that address short-, medium- and long-term agricultural production such as rising prices of farm inputs among other aspects, farmers might not benefit from the global rise in food prices due to the rising costs of production caused by the rise in the prices of farm inputs, such as inorganic fertilizers.

4.3.2 Effects of soil fertility technology on crop yields

As shown in Table 4.10, 93% of farmers in Meru South reported an increase in yields while only 7% reported no change in their crop yields. Similar findings were found among farmers in Mbeere with 74% reporting increased yields while 26% did not report any increase. The results of the study reveal the benefit accrued from combining both inorganic and organic input while replenishing soil fertility. This is in line with what Groot (1998) has reported that the best strategy to improve productivity and maintain soil fertility in sub-Saharan Africa can be found in a combination of both inorganic and organic fertilizers where the inorganic fertilizer provides most of the nutrients and the organic fertilizer increases soil organic matter status, soil structure, and buffering capacity of the soil in general. Use of both inorganic and organic fertilizers has proven to result in synergy, improving efficiency of both nutrient and water use (Groot, 1998).

Table 4.10: Observed effects of soil fertility technologies on crop yields by farmers in Meru South and Mbeere districts

Effects of technology on crop yields	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Increased yields	93	93	37	74	130	86.7
No change on yields	7	7	13	26	20	13.3
Total	100	100	50	100	150	100

4.3.3 Farmers response on application various yield improving technologies in Meru South and Mbeere districts

In addition, farmers were asked to state in their opinion whether ISFM led to increase in yields or not. 74% of the respondents in Meru South reported that their increase in yields was as a result of adopting the Integrated Soil fertility technologies while 26% associated the increase in yield to other approaches (mainly use of inorganic fertilizer alone or organic fertilizers such as manure). Similar scenario was depicted in Mbeere with 82% of farmers having adopted some kind of the ISFM technologies and 18% used the inorganic fertilizer alone on their preferred crop as shown in Table 4.11.

Table 4.11: Response of farmers on application different inputs in Meru South and Mbeere districts

Input use	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Access to new improved seeds variety	21	21	9	18	30	20.0
Use of inorganic fertilizers	26	26	3	6	32	21.3
Adoption of ISFM	40	40	27	54	67	44.7
Combined new seed variety + ISFM	13	13	11	22	24	16.0
Total	100	100	50	100	150	100

Source: Survey data (2008)

The high percent of farmers using some form of ISFM technologies was due to the realization of its benefits of increasing soil fertility. This agrees with what is reported by Groot, 1998 that the best strategy to improve productivity and maintain soil fertility is found in a combination of both inorganic and organic fertilizers. Respondents who were of the opinion that increased yields were as a result of using new improved seed variety accounted for 21% in Meru South and 18% in Mbeere district. This may be attributed to the fact that these respondents indicated that initially they used local seeds but after adopting the use of improved seeds there was increase in their yields. Those of the opinion that combined use of improved seeds and application of ISFM technologies resulted to increased yields constituted 13% of the respondents in Meru South and 22% of the respondents in Mbeere district. From this finding, it is then imperative that use of both improved seeds and employing ISFM technologies is the way forward.

4.3.4 Factors inhibiting adoption of ISFM technologies

In both districts farmers reported that although there were other factors that inhibited crop production such as increase in pests, weeds and sometimes bad weather, the main reason they did not find the introduced technologies for replenishing their soil fertility attractive is because of lack of market to sell their outputs resulting from the technology. As shown in Figure 2, none of the farmers in Mbeere continued with the agroforestry innovations introduced to them by an earlier project on ISFM. When asked why they did not use the innovations, they reported it was because they did not notice any change in their status due to lack of markets for their produce. Although the situation was slightly different in Meru South, it was only 20% of those interviewed who were receptive to the introduced agroforestry fertilizer trees. However, the same farmers pointed out that their main hindrance to wide adoption of the technologies was their inability to access market for their produce resulting from improved soil fertility. One can therefore deduce that access to markets for smallholder farmers has effects on the adoption and sustainability of the introduced agroforestry innovations.

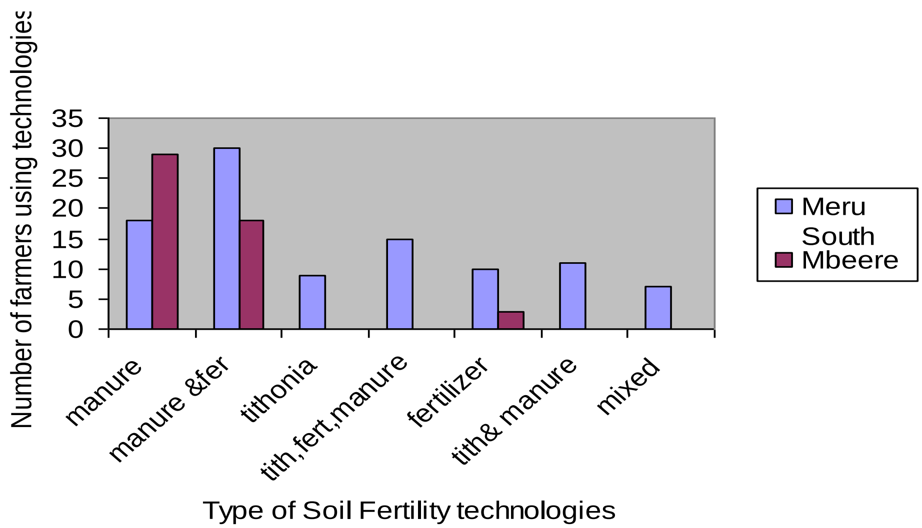


Figure 3: Type of Soil fertility technology used in Meru South and Mbeere districts

This findings agree with that of Omamo (2005) who has reported that integrating smallholder farmers into commodity chains must be a priority and only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity. In addition, CIAT (2005) reports that ISFM arose because of the recognition that addressing the interactions between components (e.g., water, pests and soils) is as important as dealing with the components themselves. However, improving the natural resource base without addressing issues of marketing and income generation (e.g. the resource-to consumption logic) seems sterile and is often the reason for a lack of adoption of improved farming practices. Therefore in order to shade more light on market dynamics of smallholder produce, a section on marketing of smallholder produce is discussed in section 4.4.

4.4 Marketing of Smallholder Produce

The second objective was to analyze marketing of smallholder crop produce. This section on marketing of smallholder produce covers types of markets; marketing channels available to smallholder farmers under study, and other aspects of transport is discussed. In addition, factors influencing the sale of a given crop are analyzed. Constraint to commercializing of agricultural produce has also been discussed.

4.4.1 Type of markets

Two broad types for markets were clearly identified as formal and informal. Formal markets have a definite location and are regulated by a public organization. Informal markets have no official form of organization or authority. However, as informal markets gain importance, they usually attract attention of authorities who ultimately bring them under their jurisdiction and charge fees (Muturi, 2001). Most of the markets in Meru South and Mbeere districts are centralized; agricultural produce is delivered to large central markets such as Chogoria, Chuka, Itugururu in Meru South district and Kiritiri in Mbeere district where individuals, retailers, wholesalers and agent middlemen buy the produce. Informal markets are, on the other hand, decentralized, and wholesalers, retailers, agent middlemen and individuals buy directly from farms or at small selling points within the production area, farmers act as their own selling agents. This made marketing interface with farm production because the farmer is both a producer and marketer of his /her own produce.

4.4.2 Marketing Channels

Farmers had multiple outlets for their crops (Table 4.12) that included selling at open markets, neighbours institutions such as hotels and hospital, urban centres and cooperatives. Selling at open air markets and institutions is predominant were found to be main outlets of farm produce in both districts. Open air markets as an outlet for smallholder farmers' accounted for 58% and 74% of respondents in Meru South and Mbeere respectively. Neighbours constituted 4% in Meru South and 46% in Mbeere. The low percentage of farmers selling to their neighbours in Meru South could be due to the fact that favourable climatic conditions enabled most farmers become self-sufficient since they cultivate similar crops on their farms. This resulted to low demand of the produce from their neighbours. On the other hand, in Mbeere district there is a slightly high percent of farmers selling to neighbours which could be attributed to the frequent drought experienced in the area which may result to crop failure hence creating a deficit among the farmers, necessitating purchase from other farmers within the area.

Institutions such as hospital, schools and even hotels play an important role in marketing of farm produce in both districts. In Meru South, farmers selling their crops through this particular channel accounted for 26% while those in Mbeere accounted for 20%. In both areas, tenders are given to the farmers to supply a given commodity consumed at the institution within a given time frame. Farmers using this option were of the opinion that it was more reliable and convenient since all that is required is to deliver the required quantity and quality of a given produce. Farmers selling their produce in urban centres accounted for 15% in Meru South and 28% in Mbeere district. The low percent in Meru

South selling through this channel as compared to those in Mbeere may be attributed to poor state and network of roads. Most feeder roads in the agriculturally high potential areas are poor thus inhibiting access to markets for farm produce resulting to low prices of products (Republic of Kenya, 2002,). In roads during rainy season these roads become impassable causing delay in marketing of farm produce and purchase of farm inputs (Republic of Kenya, 2002). In Mbeere district, access road was not viewed as inhibiting factor among the respondents although this disagrees with what is reported in the Mbeere district development plan of 1997-2001 that the district is badly served by the road network.

Table 4.12: Farmers marketing channels for crops in Meru South and Mbeere districts

Marketing channel	Meru South		Mbeere	
	*n	* %	*n	* %
Open air markets	58	58	37	74
Neighbours	4	4	23	46
Institutions- (hotels,schools,hospitals)	26	26	10	20
Urban centers	15	15	14	28
Farm gates	13	13	15	30
Others- (cooperatives, farmer groups)	16	16	1	2

Note:

*% - percent of the total do not sum up to 100%, because farmers gave more than one response
*n- total number of farmers do not sum up to 100 in Meru South and 50 in Mbeere because the respondents gave more than one response
Meru South Significance at $p \leq 0.00$ level (X2= 104.163; df = 5; $p \leq 0.00$).
Mbeere significance at $p \leq 0.00$ level. (X2= 86.24.875; df = 2, $p \leq 0.00$).

The above data was analysed using chi-square test to give degree of significance as indicated below. The results of chi-square (X2) indicate that the differences in preferred marketing channels by farmers in Meru South district were significant at $p \leq 0.00$ level. (X2= 104.163; df = 5; $p \leq 0.00$). While for the farmers in Mbeere district, the results of chi-Square indicate that the differences in preferred marketing channel by the farmers were significant at $p \leq 0.00$ level. (X2= 86.061; df = 5 $p \leq 0.00$). The farmers in both areas chose marketing channel largely due to accessibility and convenience as revealed by discussion.

Farm-gates is another important outlet where brokers come to the farms and buy, this constituted about 13% of the respondents in Meru South and 30% in Mbeere district. This is in line with the findings of Muturi, 2001 who also found that traders from outside the district and agent brokers are emerging as important marketing channel for smallholder farmers. In respect to cooperatives and farmers groups, a high proportion (16%) of farmers in Meru South district take their produce especially coffee and tea to these institutions as compared to 2% in Mbeere district. Coffee and tea was mainly found in Meru South district. Co-operatives societies more than any other support institution, have influenced agricultural commercialization among small-scale farmers in Kenya (Muturi, 2001). They are important in commodity marketing supply of inputs, and provision of credit among other services.

Farmers groups were also evident in Meru South as compared to their counterparts in Mbeere. This may be due to the fact that some farmers had realized the benefits accrued from collective marketing such bargaining power and economies of scale. These findings agree with those of Robbins *et al.,* (2003) who reports that smallholder farmers may be able to produce only small surpluses to sell in the local market, even though other farmers are capable of producing surpluses they find it difficult to transport them to a market or a roadside stall. Most farmers produce small quantities for sale but find that the local trader is only prepared to pay low prices for their goods compared with the wholesale price. As individual farmers they have little bargaining power with traders and must often accept almost any price offered hence the need for them to organize themselves into farmers marketing groups.

4.4.3 Factors considered by farmers when selling their produce

A number of factors are considered by farmers when selling their produce. Figure 3 indicates that price offered to farmers accounted for 23% and 50% of the respondents in Meru South and Mbeere district respectively when selling their produce. Smallholder farmers often produce and supply to the market small quantities which hampers their bargaining power for good prices. Robbins *et al.,* (2003) reports that smallholder farmers may be able to produce only small surpluses to sell in the local market and as a result local traders or buyers are only prepared to pay low prices for their goods. In addition, Heinemann (2002) noted that rural people in Africa, even those farmers who produce a surplus remain trapped in the poverty cycle due to lack of access to profitable markets. All too often farmers are forced to sell to the buyer of convenience at whatever price that buyer dictates (IITA, 2001).

Pressing household needs for cash is an important factor influencing farmers' decision to sell a particular crop produce in the two sites. It accounted for 53% and 32% of respondents in Meru South and Mbeere districts respectively. The results agree with that of Muturi (2001) who reports that farmers produce crops for the market so as to generate cash for essential household needs such as payment of school fees, clothing and medical expenses among other expenses.

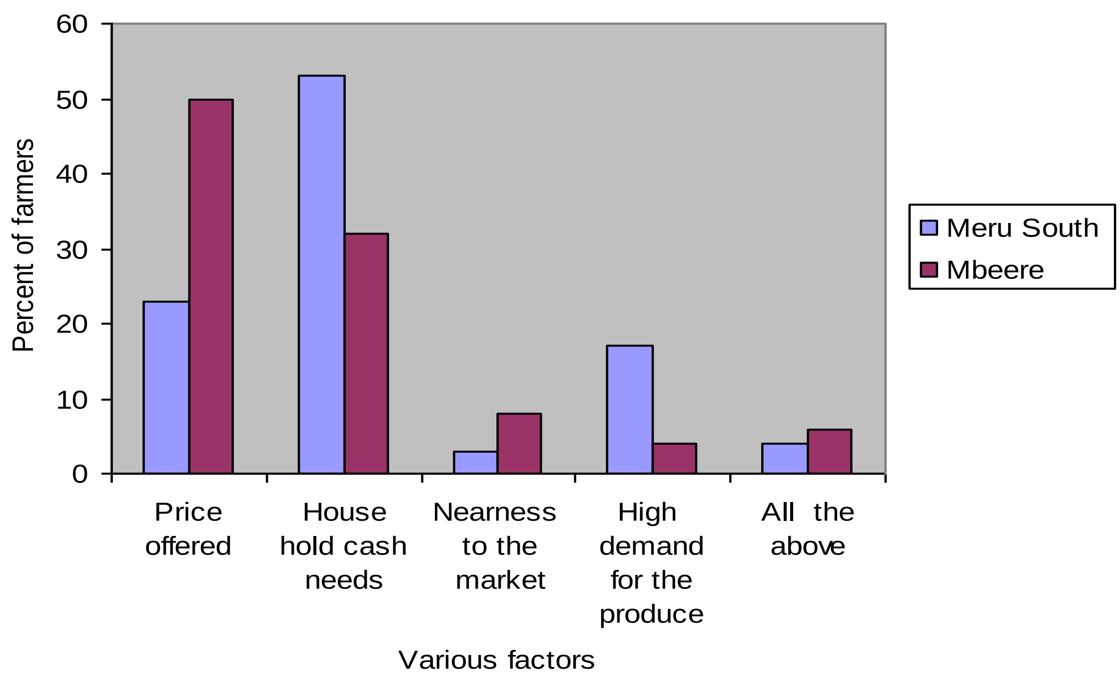


Figure 4: Factors that were considered by smallholder farmers when deciding to sell their produce. (Source: survey data)

Market proximity or nearness was considered as a motivating factor by 3% of farmers in Meru South and 8% in Mbeere district when making a decision to sell their crop produce.

Most farmers regarded nearness to the market not a necessarily factor in attracting one to sell his or her produce if other factors such as prices offered are not appealing. Republic of Kenya, (2002) notes that most farmers lack market information and skills thus making hampering the expansion of the commodity markets.

The high demand for the produce is another factor that influences farmers to sell their produce with 17% and 4% of the respondents in Meru South and Mbeere districts respectively. Despite the fact that majority of the farmers produce almost similar crops, the high demand for the produce could be attributed to high population density and many networked market outlets. About 4% and 6% of the respondents in Meru South and Mbeere districts respectively felt that all the above factors were a consideration while deciding to sell their crops.

4.4.4 Constraints to Crop Marketing in Meru South and Mbeere districts

Increased commercialization of agriculture has been seen as an integral part of increasing incomes and improving living standards of rural areas of many developing countries (von Braun and Kennedy, 1986). Commercialization links individuals and even household to local and international markets. This linkage is crucial as markets can have synergetic effects on the process of rural development. However, commercialization of smallholder produce is constrained by a number of factors, some of which are specific to the farmers themselves and others emanate from the prevailing socioeconomic circumstances they find themselves in. Farm households interviewed during field survey were requested to indicate the factors that prevent them from increasing their marketed surpluses. These factors were categorized into two main parts that is market related factors and household related factors; each had a number of factors that constituted it.

4.4.4.1 Household related constraints to crop marketing

As shown in Table 4.13, lack of capital to buy inputs accounted for 64% and 32% in Meru South and Mbeere respectively. As mentioned earlier in Table 4.9 the farmers inability to purchase inorganic fertilizers has made many of them to turn to organic and other methods combining organics and inorganic in order to achieve the desired results. As noted by Chinagwa (2006), the use of inorganic fertilizers as an option for improving soil fertility and productivity has immediate results but is unaffordable to most farmers.

Table 4.13: Household related constraints to crop marketing in Meru South and Mbeere districts

HH constraints	Meru South		Mbeere	
	n	%	n	%
Household labour shortage	46	46	41	82
Farm labour too expensive to hire	42	42	22	44
Chronic illness in the family	2	2	1	2
Lack of capital to buy inputs	64	64	16	32
Lack of land to grow crops or insecure land secure tenure	6	6	6	12
Lack of knowledge about yield improving farming technologies	16	16	23	46
Lack of capital for land preparation	32	32	7	14

hh =household

*% - percent of the total do not sum up to 100%, because farmers gave more than one response
*n- total number of farmers do not sum up to 100 in Meru South and 50 in Mbeere because the respondents gave more than one response

The above data was analysed using chi-square test to give degree of significance as indicated below. The results of chi-square (X2) indicate that the differences in household constraints among farmers in Meru South were significant at $p \leq 0.00$ level. (X2= 65.900;

df = 6; $p \leq 0.00$). While for the farmers in Mbeere district, the results of chi-Square indicate that the difference in marketing constraints among the farmers were significant at $p \leq 0.024$ level. ($X2= 5.120$; df=1; $p \leq 0.024$). The differences in significant levels in the two regions may reveal that farmers in Mbeere face more socio-economic challenges as compared to their counterparts in Meru South.

Household labour shortage was viewed as a major constraint to crop production in both areas accounting for 46% and 82%of the respondents in Meru South and Mbeere district respectively. The high percent of farmers experiencing this problem in Mbeere could be attributed to the fact that due to poor climatic conditions experienced in the area leading to low crop yields; many sell labour to other farmers in order to get their daily bread. Sale of labour is however, an indicator of poverty among rural households. Chronic illness in the family was not a major factor among the households interviewed in Mbeere and Meru South districts. This constituted to only 2% of total respondents in each site thus implying that farmers are fit to market their produce if an enabling environment is created. In addition, well being of the farmers is an indicator of the ability of the farmers to work on their farms during planting seasons as well as to market their produce.

The farmers who reported land shortage as a factor accounted for only 6% of the respondents in Meru South and 12% in Mbeere district. Land shortage being experienced in Meru South may be due to high population density resulting to subdivision of existing land parcels into uneconomic units (Republic of Kenya, 2002). Farmers in Mbeere district facing land shortage indicated that during periods of favorable weather, they lack capital to hire/lease land hence producing less at the end of the season. With better market for their yields the problem of small farm sizes could be solved by farmers hiring more land for cultivation. Farmers should also endeavour to improve production within small farms and can offer their labour for sale as noted in Technical MATF report, (2005).

Farm labour to some respondents was too costly to hire as reported by 42% of the farmers in Meru South and 44% in Mbeere district. This could be attributed to the fact that respondents in both areas relied heavily on their farms as the main source of livelihood. There are also low levels of formal education hence the inability of the farmers to get cash from other sources to pay for their hired labour. This findings agree with what Cavendish (2001) has reported that rural households have little formal education and employment is proportional to formal education (Wang'ombe, 2004).

Other respondents indicated that lack of capital to prepare land was another limiting factor with 32% of farmers in Meru South and 14% in Mbeere district identifying this as a constraint. The low percent of the respondents in Mbeere district could be attributed to the fact that many households use oxen to plough their land. This required low capital as compared to the use of machineries like tractors or human labour needed to dig the land.

Lack of knowledge on improved technologies was perceived by 16% of farmers in Meru South and 46% in Mbeere district. This may be attributed to lack of proper extension services dissemination in the two districts especially in Mbeere. This is irrespective of the fact that the majority of the respondents are literate as shown in Table 4.2. The finding of this study agree with Technical MATF report of 2005, that lack of knowledge and extension services were major problems among smallholder farmers. However, this problem can be solved by increasing extension staff and who should also involve farmers in decision making processes.

4.4.4.2 Market related constraints to crop marketing

As shown in Table 4.14, 83% of the farmers in Meru South and 64% in Mbeere district felt that low or fluctuating produce prices was a major hindrance to crop marketing. Smallholder farmers often produce and supply to the market small quantities which hampers their bargaining power for good prices. Robbins *et al.*, (2003) reports that smallholder farmers may be able to produce only small surpluses to sell in the local market and as a result local traders or buyers are only prepared to pay low prices for their goods. Another factor that may result to fluctuating prices may be due to the fact that farmers in both areas tend to cultivate similar crops in given growing season and therefore flood the market with similar produce hence supply in such occasions exceed demand contributing to low prices offered. These findings agree with that of Muturi (2001) who found that price fluctuations cited by farmers can be attributed to supply and demand in the local market for a given produce. It is therefore important for farmers to be educated on enterprise selection to avoid total duplication of commodities in the market and also aspects like post harvest functions such as grading, preservation among others.

Table 4.14: Market related constraints to crop marketing in Meru South and Mbeere districts

Factors	Meru South		Mbeere	
	* n	* %	* n	*%
Low or fluctuating produce prices	83	83	32	64
Untimely payment for crops	7	7	2	4
High transportation costs	31	31	2	4
Unreliable market outlet	11	11	5	10
High prices for modern inputs (seeds, fertilizers, pesticides)	42	42	42	84
Unavailability of modern inputs	1	1	4	8
Lack of credit facilities	8	8	1	2

Key

*% - percent of the total do not sum up to 100%, because farmers gave more than one response
*n- total number of farmers do not sum up to 100 in Meru South and 50 in Mbeere because the respondents gave more than one response

The above data was analysed using chi-square test to give degree of significance as indicated below. The results of chi-square (X2) indicate that the differences in marketing constraints among farmers in Meru South were significant at $p \leq 0.00$ level. ($X2= 90.260$; $df = 6$; $p \leq 0.00$). While in Mbeere, the results of chi-Square indicate that the difference in marketing constraints among the farmers were significant at $p \leq 0.024$ level. $X2= 5.120$; $df=1$; $p \leq 0.024$). Smallholder farmers in both areas do face constraints while marketing their produce irrespective of where they come from hence the need to assist them on the aspect of marketing.

Untimely payment after delivering the crops was not viewed as a major problem. However, in Meru South, 7% of the respondents saw this as a setback in the bid to market their produce. This was specifically noted among those farmers who sold their crops through cooperatives such as coffee or tea. Those respondents supplying institutions experienced similar problems. In Mbeere district, it was only 4% of the respondents who mainly sold through institutions. They all mentioned that in many occasions they were required to wait for cheques to mature thus limiting them from using cash needed immediately. Similar findings are reported by Muturi (2001) that individual small-scale farmers selling through cooperatives for example are not in full control of the marketing of their produce.

Some respondents felt that high transportation costs were a major hindrance inhibiting them from adequately marketing their produce accounting for 31% and 4% of respondents in Meru South and Mbeere districts respectively. For instance, in Meru South, most of feeder roads in the agriculturally high potential areas are poor, inhibiting access to markets for farm produce resulting to low prices of products. In addition, impassable roads during rainy season cause delay in marketing of farm produce and purchase of farm inputs (Republic of Kenya, 2002). In Mbeere district, access road was not viewed as a major inhibiting factor. The findings of this study therefore agree with that of Muturi (2001) who reports that availability of transport and cost have significant effect on production and marketing costs. In addition, in a report by MATF (2005), it was found out that smallholder farmers faced problems of lack of infrastructure to enable them reach markets. Odhiambo (1998) has reported that in SSA, many governments have been unable to provide adequate lengths of roads necessary while the existing ones have been inadequately maintained. Feeder roads where they exist have deteriorated and trucks cannot go into the rural areas because of high maintenance costs.

High prices for modern inputs were viewed as a hindrance to crop marketing in both Mbeere and Meru South districts. Fourty two percent of the respondents in Meru South and 84% in Mbeere reported that modern inputs were out of reach for them. Inputs such as inorganic fertilizers which are predominantly purchased by most farmers is on the decline as shown in Table 4.9 where it was found that only 10% and 6% of the farmers in Meru South and Mbeere respectively still use inorganic fertilizers. As a result farmers are opting for alternative sources for replenishing their soils and planting materials. Muturi (2001) also reports that some farm inputs such as seed and manure are generated on-farm. This then may be an indicator of high cost of purchasing inputs facing the farmers.

Access to credit for financing investment and farm operations is crucial to commercialization of smallholder agriculture (Muturi, 2001). However, in this study a small proportion of farmers that constituted 8% and 2% of the respondents in Meru South and Mbeere districts respectively regarded lack of credit facilities as a hindrance to crop marketing. This could be attributed to lack of farmers' knowledge on issues relating to agricultural (Muturi 2001). This has greatly hindered development especially in Mbeere district since most farmers cannot undertake adequate farm development because of their inability to acquire inputs (Republic of Kenya, 1997). The number of farmers in need of credit is high considering that majority of the respondents cited lack of capital, high transport and inputs costs as major constraints to crop production. There is need for extension workers to create awareness amongst smallholder farmers on credit availability in the study areas that is who offers credit and where it can be found.

Unavailability of modern inputs was not perceived by many as a big problem as indicated by only 1% of respondents in Meru south and 8% in Mbeere districts. Majority of the respondents indicated that modern inputs were indeed available but the challenge was finding capital to acquire them from the markets. A unreliable market outlet as a constraint to crop marketing was reported by 11% and 10% of the respondents in Meru South and Mbeere districts respectively. In Meru South, some respondents reported that some farmer's cooperatives had collapsed, hence the farmers found it difficult to sell whatever little they produced. Similar sentiments have been noted in Technical MATF report (2005) that cooperatives serving farmers were no longer functional. Farmers in Mbeere district reported that whenever they availed their goods to the market where they thought there was high demand, they ended up being disappointed since low prices were offered by the buyer/traders. Therefore, there is need for farmers to understand their market niche hence establish when to supply given commodities to a given market. This can be achieved by such farmers concentrating on aspects such as post-harvest functions. Muturi (2001) notes that the time lag between harvesting and selling implies that farmers store some of their produce. This is because storage loss is one of the factors that influence the efficiency in marketing. Other post- harvest functions that can be undertaken by the farmers include shelling, preservation, grading and processing of their produce.

4.4.5 Contractual farming

As shown in Table 4.15, 82% and 92% of the respondents in Meru South and Mbeere districts respectively reported that they did not grow crops on pre-arranged contracts with traders or buyers. Eighteen percent of the respondents in Meru South and 8% of respondent in Mbeere district grew crops on some kind of pre-arranged contracts. Farmers in Meru South seemed to have an increasing awareness on pre-arranged contracts as compared to their counterparts in Mbeere district. These contracts are mainly with school, hospitals, hotels and even certain traders in the market. This implies that the farmers were not just producing for the sake of it but rather had a target where their produce would finally be disposed off. These findings agree with Odhiambo (1998) that production based on the market availability might motivate some farmers to shift from subsistence production to commercialized agriculture and hence making smallholder production an attractive venture.

Table 4.15: Farmers response on pre-arranged contracts in Meru South and Mbeere districts

Response	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Yes	18	18	4	8	22	14.7
No	82	82	46	92	128	85.3
Total	100	100	50	100	150	100

4.5 Income

In this section, the sources of income available to smallholder farmers are reported. The aim of this is to try to find out whether sale of crops is among the major contributor to the household income and therefore providing an insight to whether the ISFM technologies are applied on those crops that generate income most.

4.5.1 Sources of income for smallholder farmers in Meru South and Mbeere districts

Income sources for smallholder farmers were diverse and ranged from sale of crops to wages (Table 4.16). Eighty one percent of respondents in Meru South and 36% in Mbeere district indicated sale of crops as the main source of income. The high percent of farmers accruing income from sale of crops in Meru South as compared to their counterparts in Mbeere district could be attributed to high production due to favourable climatic conditions experienced in the area (Jaetzold and Schmidt, 1983). In addition, in Meru South farmers cultivated cash crops such as tea and coffee which were sold to cooperatives for further processing and therefore these farmers receive good returns from such cash crops. Non-farm salaried employment accounted for 6% of the respondents in Meru South and 36% in Mbeere districts. The high percentage of non farm salaried employment in Mbeere could be largely influenced by factor of weather condition as mentioned above and farmers are forced to seek alternative sources of income due to unstable weather patterns which results to frequent droughts hence crop failure.

Table 4.16: Main sources of income for smallholder farmers in Meru South and Mbeere districts

Income source	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Sale of crops	81	81	18	36	99	66
Non-farm salaried employment	6	6	18	36	24	16
Micro-business	5	5	6	12	11	7.3
Remittance from absent hh members	6	6	1	2	7	4.7
Pension	2	2	-	-	2	1.3
Sale of labour	-	-	7	14	7	4.7
Total	100	100	50	100	150	100

Income from absentee household members was the lowest source in both study regions constituting about 2% in both districts. This could be attributed to education level. The proportion of those who had tertiary education and legible for formal employment was very low (5% in Meru South and 8% in Mbeere district). Cash needs based on employment is not highly considered by majority of local households in both study sites that is it is unevenly distributed and also unreliable in both areas. These findings agree with that of Wang'ombe (2004) who reports that employment is proportional to formal education.

Other sources included micro businesses that accounted for 5% and 12% of the farmers in Meru South and Mbeere respectively. These were mainly in form of kiosks and shops that were found along the roads and village centers. In Mbeere district 14% of respondents earned their income in form of wages by working in other people's farms. This was not observed in Meru South district. Sale of labour in Mbeere district could be an indicator of high poverty levels in the area. The scenario could be contributed by a number of factors such as the agro-ecological zone lying in the marginal cotton zone (LM4) (Republic of Kenya, 1997 which has unreliable rainfall pattern hence the area experiencing frequent droughts resulting to crop failure. This could then force some farmers to sell their excess manpower in order to meet their human needs. Another factor that was identified in Meru South is low levels of education among the farmers which could have made them unable to secure formal employment as stated by Wang'ombe (2004).

In general, sale of crops contributed high to source of household income with 66% of the total households interviewed. This is in line with the findings of Odhiambo (1998) who found that over 80% of the Kenyan population live in the rural areas and derive their livelihoods, directly or indirectly from agriculture. Non- farm employment, micro business, remittance from absentee household members, sale of labour and pension represented by 16%, 7.3%, 4.7%, 4.7% and 1.3% respectively are other important sources of household income. There is need for project developers and government to promote this sector. As stated by Njehia (1994) that with increasing focus on rural population all over the developing countries, strategies for the achievement of faster and equitable economic growth are taking centre stage. This emphasis has been partly due to the recognition of the fact that most of the population in the third world economies resides in rural areas and practice farming as a main economic activity (Odhiambo,1998). Therefore, increased commercialization of agriculture has been seen as an integral part of increasing incomes and improving living standards of rural areas of many developing countries (von Braun and Kennedy, 1986).

4.5.2 Average income from preferred crops

As shown in Table 4.18, majority of the farmers received between Ksh. 1,001-5,000 with 42% and 68% of farmers in Meru South and Mbeere districts respectively per harvest season. Farmers in Meru South receiving an income of Kshs. 5,001-10,000 made up 25% while those in Mbeere district constituted 22%. Those individuals earning over Ksh. 10,000 were more in Meru South (27%) and 4% in Mbeere district. The high number of farmers in Meru South earning over Ksh. 10,000 may be due to the kind of crops traded for instance cash crops such as coffee and tea that normally fetch high returns. On the other hand farmers in Mbeere district sold mostly cow peas and green grams whose economic value may not equal that of coffee and tea. In addition, unfavorable weather patterns may be a contributing factor to reduced quantity of crop produce harvested in the area hence low yields. This may limit the amount availed to the market. As reported by (Republic of Kenya, 1997) agriculture and livestock production are the main source of income for the population in Mbeere district. However, due to unfavourable climatic conditions prevailing in most parts of the district, surpluses in food crop production are rare.

It is therefore imperative that sale of crops among smallholder farmers is a major contributor to household income in the study regions. These findings agree with Muturi (2001) who identified one important role of agriculture as the generation of farm incomes beside other functions like food production among others.

Table 4.17: Average income from sale of preferred crops among smallholder farmers in Meru South and Mbeere districts (income per harvest season)

Amount	Meru South		Mbeere		Total	
(Kshs)	n	%	n	%	n	%
< 1000	6	6	3	6	9	6
1001-5000	42	42	34	68	76	50.7
5001-10,000	25	25	11	22	36	24
Above 10, 000	27	27	2	4	29	19.3
Total	100	100	50	100	150	100

Meru South had more farmers who regarded marketing of their produce as main source of their livelihood as compared to their counterparts in Mbeere district. This could be attributed to the difference in the agro-ecological zones with one Meru South favouring crop production than in Mbeere. As reported by Omamo (2005) the future of smallholder agriculture will be defined by the degree to which smallholders are able to embrace farming as a business. Integrating smallholder farmers into commodity chains must be a priority and only then will they be able to respond to market incentives, adopt technologies, uplift incomes, and deal with food and nutrition insecurity. This then implies that any effort placed to enhance soil fertility and ultimately crop yields may be welcomed since the farmers see the value of investing in such technologies. It is important therefore to note that when farmers become oriented to the market they will be able to try diverse types of technologies that are introduced to them; this could be explained by a slightly wide practice of ISFM technologies in Meru South as compared to Mbeere.

4.6 Integrated Soil Fertility and Marketing of smallholder produce

The third objective of the study was to determine the linkage between ISFM technologies and marketing of smallholder produce in Meru South and Mbeere districts.

Linking the technology development process to market opportunities has the potential to promote links between investment in natural resources, markets, and adoption of technologies (Delve *et al*., 2003). Market orientated agriculture for reducing poverty and environmental degradation needs to centre on three related paradigms; strengthening biological processes in agriculture (to optimize nutrient cycling, minimize external inputs and maximize the efficiency of their use); building farmer's capacities (to learn and innovate focused on improving livelihoods through market opportunity identification and the management of natural resources); and developing forward and backward linkages (between natural resources, production and markets) (Ibid).

The growth of agricultural production to a large extent depends on several factors such as land-use pattern, agricultural inputs that is inorganic and organic, improved seeds, infrastructure availability and adoption of improved farming technologies (Odhiambo, 1998). In this section, the relationship between integrated soil fertility and marketing of smallholder produce is discussed under various variables that were identified during field the survey. In order to provide a better understanding, the section is divided into the following; high yielding varieties seeds, land-use pattern and crop utilization.

4.6.1 High Yielding Variety Seeds

The adoption of high yielding variety seeds is widely being employed by many farmers whose bid is to see increase in the yields from their farms (Odhiambo, 1998). The aims of this study is to find out whether farmers are adopting more of high yielding varieties with a degree of exchange in mind beside subsistence use. As shown in Table 4.18, 74% of the respondents in Mbeere used either improved or high yielding varieties for their preferred crops especially maize while 26% of farmers still used local varieties. The use of local varieties was common for beans, millet and cow peas. Similar scenario was depicted in Meru South where 78% of the respondents used high yielding varieties while 22% planted local varieties. The slightly high percent of farmers in Meru South using improved varieties of planting materials may be attributed to intensive cultivation where farmers expect to reap more produce from the highly subdivided parcels of land, hence their preference for improved seeds. In addition, as indicated in section 4..4.1 that 81% of the farmers receive income from sale of crops, this may determine their choice of planting materials so as to accrue maximum benefits from their main source of livelihood.

Table 4.18: Type of crop variety seed planted by smallholder farmers in Meru South and Mbeere districts

Seed variety	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Improved seeds /hybrid	78	78	37	74	115	76.7
Traditional	22	22	13	26	35	23.3
Total	100	100	50	100	150	100

Farmers in Mbeere are also adopting the use of improved varieties because of the need to grow seeds that are fast maturing and high yielding largely due to unfavourable weather patterns experienced in the area. When the farmers were asked the reason for using high yielding varieties, most of them reported that they wanted to increase their yields so that they could have some for consumption and the remaining could be sold to generate income.

For farmers planting maize, all of them used hybrids since they had ease access to the market. The same applied to other crops whose accessibility to the market was easy as compared to those farmers who had medium or difficult access to the market. These findings agree with those of Atieno and Alila (2006) who has reported that due to limited availability of high potential land, it has been envisaged that increasing agricultural production will have to come from intensification of production through increased use of improved inputs. Njehia (1994) reports that to maximize their profits, the farmers will always go for technologies that would further contribute to increase in their productivity. For instance, farmers planting maize in Meru South and Mbeere districts used hybrids since they had ease access to the market, the same applied to other crops whose accessibility to the market was easy as compared to those farmers who had medium or difficult access to the market.

4.6.2 Land-use Pattern and Market Access

Farmers are usually exposed to a risky production and market environment and they therefore consider numerous factors when deciding what to produce. The expectations regarding crop and input markets and related risks are major determinants of the combination of farm enterprise a farmer goes for (Njehia, 1994). Easy access to markets made possible for example by close proximity of farms to markets promotes production of an efficient combination of products in line with the principle of comparative cost advantage (Odhiambo, 1998). As shown in Table 4.19, maize was allocated 38.5% and 42.2% of land in Meru South and Mbeere districts respectively. Beans occupied 26.4% of land under cultivation in Meru South and 24.9% of land in Mbeere. Coffee and banana which were cultivated by farmers in Meru South alone occupied respectively 22.3% and 12.8% of cultivated land. On the other hand, green grams and cowpeas which were characteristic crop for farmers in Mbeere district respectively constituted 17.4% and 15.5% of total cultivated area in Mbeere district. It was found out that access to markets was a major factor that influenced farmers' decision on selection of crop enterprise to cultivate. This finding is in line with that of Odhiambo (1998) who reports that high value products such as vegetables become attractive to produce since they can easily be sold in the nearby markets.

Table 4.19: Land under selected crop enterprise among smallholder farmers in Meru South and Mbeere districts

Crop enterprise	Meru South		Mbeere		Total	
	n	%	n	%	n	%
Bananas	21.4	12.8	-	-	21.4	5.8
Coffee	37.3	22.3	-	-	37.3	10.2
Maize	64.5	38.5	83.8	42.2	148.3	40.5
Beans	44.2	26.4	49.5	24.9	93.7	25.6
Green grams	-	-	34.6	17.4	34.6	9.5
Cowpeas	-	-	30.8	15.5	30.8	8.4
Total	167.4	100	198.7	100	366.1	100

n = acrearage under cultivation

Another aspect that was evident from the study was enterprise mix that characterized the land use pattern in both areas. For instance, with the prevailing conditions of small land sizes, it was found out that a farmer would only select that enterprise that he or she would be able to access the market easily and hence allocate a slightly larger portion of land. In Meru South and Mbeere districts all farmers practiced mixed cropping on their farms with the most common being maize and beans. Others included cowpeas or green grams on any piece of land under cultivation. In addition, in Meru South, farmers would grow beans under coffee bushes with an effort to maximize returns from small parcels of land devoted to cultivation. These findings agree with that of Muturi (2001) who reported that farmers engage in multiple cash generating enterprises is an indicative of their desire to generate cash incomes from diverse sources and also to avoid risks.

However, it is important to note that as a country moves towards commercialized agriculture, agricultural production mix at the farm level will change to reflect the changes in access to markets (Odhiambo, 1998). This will also be expected among smallholder farmers in Meru South and Mbeere districts where some may opt for high value horticultural crops like French beans thus shifting from the traditional crops grown in the area. Market accessibility has therefore a positive relationship on the allocation of land on specific enterprise which may influence the type of ISFM technologies that farmers adopt or apply in the long run.

4.6.3 Crop use in Meru South and Mbeere districts

Like many other semi-commercial farmers anywhere else in the developing world, farmers surveyed in this study are exposed to risks in production and marketing

(Odhiambo, 1998). To minimize these risks, a number of factors were considered when making a decision to cultivate a particular crop. Therefore, farmers were asked to indicate utilization of main crops on their farms and state reason for their choices. As shown in Table 4.21, 87% and 90% of the farmers in Meru South and Mbeere respectively, grew crops for subsistence. The high percentage may imply that farmers in both areas considered self sufficiency on food a priority. This agree with the findings of Muturi (2001) who reports that the degree of self-provision among smallholder farmers is high, indicating a reasonably high degree of self-sufficiency in basic foodstuffs for the majority of households.

Table 4.20: Crop use in Meru South and Mbeere districts

Crop use	Meru South		Mbeere	
	* n	* %	*n	* %
Home consumption	87	87	45	90
Sale	89	89	20	40
Payment for labour	24	24	-	-

Key

*n - number of respondents does not equal N=100 in Meru South and N=50 in Mbeere because respondents gave more than one response
*%- percent of respondents do not sum up to 100% because respondents gave more than one response

Crops for sale constituted 89% and 40% of the respondents in Meru South and Mbeere districts respectively. The high percent of farmers in Meru South, who grow crops for sale as compared to Mbeere may be attributed to the kind of crops grown in each region. For example in Meru South, coffee was identified as one of the main cash crops which require that once harvested, all is sold to respective coffee cooperatives for further processing. This then may be the reason for a high percent of those farmers selling crops in Meru South as compared to those in Mbeere. On the other hand, in Mbeere district, their common cash crops were maize, beans, cowpeas and green grams which meant that part of the produce is set aside for home consumption. Due to unreliable rainfall and frequent drought experienced in the area (Republic of Kenya,1997), farmers in Mbeere district reserve more grain as a way managing household food insecurity in the event of crop failure or low yields in a given season. This made them avail little produce to the market for sell. The food policy in Kenya encourages small-scale farmers to produce sufficient food–stuffs to meet their household nutritional requirements and, where possible, offer excess for sale (Muturi, 2001).

Farmers in Meru South allocated some produce to pay for hired labor to substitute family labor and this accounted for 24% of the total respondents in Meru South. Payment of labour using crops was not reported among sampled farmers in Mbeere district. The inability of farmers in Mbeere district to use harvested crops to pay for labour may be because of insufficient crop yields largely influenced by the agro-ecological zone it lies in that is it lies in marginal cotton zone (LM4) with unreliable rainfall (Republic of Kenya, 1997) where farmers would give priority to home consumption than sale. Part of the money received from sale of crops may be used to pay for labour. It is also important to note that sale of labour was very common in Mbeere district, implying that household members would instead work in other peoples farms in order to earn a few shillings hence contributing to the absence of those paying for hired labour in the area.

4.7 Computing Correlation Analysis on various variables using spearman's rho correlation analysis

In the an effort to bring out the relationship between integrated soil fertility technologies and marketing of smallholder produce in Meru South and Mbeere districts, various variable were subjected to Spearman's rho correlation analysis. Data on total ptoduction were correlated with data on type of soil enhancing technologies and type of crop variety planted. Correlation analysis was also done on production resulting from adoption of different soil fertility technologies to market related and household related constraints

Table 4.21: Relating total production during a season (bags) to the type of soil fertility enhancing technologies among smallholders farmers in Meru South and Mbeere district.

	Meru South		**Mbeere**	
	Total production in a season	**Type of technology used in cropping**	**Total production during a season**	**Type of technology used in cropping**
Spearmans rho Total production during the season (bags Correlation coefficient Sig (2-tailed) N	1.00 . 82	-0.287 0.009 82	1.000 . 23	0.666*** 0.001 22
Type of technology used Correlation coefficient Sig (2 tailed) N	-0.287*** 0.009 82	1.000 1 100	0.666*** 0.001 22	1.000 . 48
Correlation significance	0.01		0.001	

Significance level $p \geq 0.01$

Total production in a season in relation to the type of soil fertility enhancing technology indicates that correlation was significant at 0.01 and 0.001 levels in Meru South and Mbeere respectively. This may imply that the type of soil fertility enhancing technology used by a farmer would influence the total production in a given season, if other factors are held constant. Thus it is important that attention is paid on marketing aspect among the farmers so as to ensure adoptability and sustainability of these introduced soil fertility technologies.

Table 4.22: Relating total production in a season (bags) to the type of crop variety planted by farmers in Meru South and Mbeere districts.

	Meru South		**Mbeere**	
	Total production in a season	**Type of crop variety**	**Total production in a season**	**Type of crop variety**
Spearmans rho Total production during the season (bags Correlation coefficient Sig (2-tailed) N	1.00 . 82	0.280*** 0.011 82	1.000 . 23	0.117*** 0.596 23
Type of crop variety used Correlation coefficient Sig (2 tailed) N	0.280*** 0.011 82	1.000 . 100	-0.117*** 0.596 23	1.000 . 50
Correlation significance	0.05		-	

Significance level stands at $p \leq 0.05$

Correlation between total production and type of crop variety planted by farmers in Meru South was significant at 0.05 level while in Mbeere there was no significance level indicated. In Meru South, there was a positive correlation between total production and type of crop variety planted. This can be largely attributed to the level of market orientation among the farmers and the need to produce more from slightly fragmented pieces of land in Meru South as compared to Mbeere district where despite characterized by large sizes of land other factors like climatic conditions greatly influenced crop production.

Table 4.23: Relating production resulting from adoption of different soil fertility technologies to market related constraints among farmers in Meru South and Mbeere districts

	Meru South		**Mbeere**	
	Type of technology	**Market related constraints**	**Type of technology**	**Market related constraints**
Spearmans rho Type of technology Correlation coefficient Sig (2-tailed) N	1.000 . 100	0.202*** 0.044 100	1.000 . 50	-0.374*** 0.008 50
Market related constraints Correlation coefficient Sig (2 tailed) N	0.202*** 0.044 100	1.000 . 100	-0.374*** 0.008 50	1.000 . 50
Correlation significance	0.05		0.01	

Significance level at p$\geq$ 0.05

The correlation significance level indicated at 0.05 level in Meru South and 0.01 level in Mbeere may reveal that irrespective of type of soil enhancing technologies used in production by farmers in both districts, they are still faced with challenge of marketing their produce thus marketing aspect should be included into development agenda of project developers working with the farmers e.g those on ISFM projects. The difference in significance level could be attributed to the degree of market orientation by farmers in both districts with farmers in Meru South are more oreiented to the market than their counterparts in mbeere district.

Table 4.24: Relating production resulting from adoption of different soil fertility technologies to household related constraints among farmers in Meru South and Mbeere districts

	Meru South		**Mbeere**	
	Type of technology	**Household related constraints**	**Type of technology**	**Household related constraints**
Spearmans rho Type of technology Correlation coefficient Sig (2-tailed) N	1.00 . 100	-0.284*** 0.004 100	1.000 . 50	-0.374*** 0.008 50
Household related constraint Correlation coefficient Sig (2 tailed) N	-0.284*** 0.004 100	1.000 . 100	-0.374*** 0.008 50	1.000 . 50
Correlation significance	0.01		0.01	

Significance level at $p \geq 0.01$

The correlation significance level indicated at 0.01 level in Meru South and 0.01 level in Mbeere may reveal that irrespective of type of soil enhancing technologies used in production by farmers in both districts, they are still faced with household related constraints while marketing their produce. Some of these household related factors can be solved if these farmers could access profitable markets hence the need for project developers on ISFM to put into consideration commodity chains into their agendas

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5. Introduction

In an attempt to study the linkage between integrated soil fertility management technologies and marketing of smallholder produce in Meru South and Mbeere districts, 150 smallholder farmers were interviewed (100 farmers in Meru South and 50 farmers in Mbeere), three focused group discussions were held(2 being in Meru South and 1 in Mbeere district) and direct observations were also made. Data gathered was analyzed. Based on the findings, conclusions were drawn and recommendations made on sustainable natural resource management strategies. Areas for further research were also suggested which could complement the study.

5.1 Conclusion

This study tried to provide vital information on the linkages between ISFM and marketing of smallholder produce in Meru South and Mbeere districts, Kenya. Specifically, the study identified the various ISFM technologies among smallholder farmers, analyzed marketing of smallholder crop produce and finally determined the linkage that exists between the various ISFM technologies and marketing of smallholder produce. The first objective of the study was to identify the various ISFM technologies that have been introduced and adopted by smallholder farmers in Meru South and Mbeere districts, it can be concluded that all the farmers have been introduced to one or more soil fertility technologies beside the well known use of inorganic fertilizers. Some of these ISFM technologies included the use of manure, use of tithonia, combination of manure plus fertilizers, use of tithonia, fertilizer plus manure, inorganic fertilizer and tithonia plus manure. In most of the households they use a combination of different inputs while cultivating their crops. However, farmers in Mbeere district differed with those in Meru South in that although they had been introduced to ISFM technologies, none was using fertilizer tree-shrubs such as tithonia on their soils at the time of the survey, despite them acknowledging that it was economical and improved their yields. All the respondents gave their reason for abandonment of the introduced ISFM technologies being their inability to find profitable market for their produce hence making the introduced technology unattractive and therefore lack of investment.

Farmers in Meru South seemed to have accepted the technology and a few practiced them, however the scale to which adoption is low. Farmers in Meru South were more oriented to the market than their counterparts in Mbeere district and were mainly influenced by the nature of crops cultivated such as coffee and tea which was all for the market.

Farmers in the study areas have access to both formal and informal markets, farmers in Meru South having more access to formal markets where they take their produce to Itigururu, Chogoria and Chuka while those in Mbeere district have access to Kiritiri market. In both districts the most common marketing channel for smallholder produce was through open air markets, followed by institutions such as schools, hotels and hospitals. Other forms of marketing outlets include cooperatives, neighbours, farm gates and urban centers such as Embu and Meru town. Majority of the farmers interviewed used public transport to avail their produce to their respective selling points. Head loads was also another option preferred by farmers in Meru South, however, this mode of transport was limited by quantity carried at any given time. There are a number of factors that are considered by farmers before selling their produce. Some of these factors are household related.

Commercialization of smallholder produce is constrained by a number of factors, some of which are specific to the farmers themselves and others emanate from the prevailing socioeconomic circumstances they find themselves in. Low produce/fluctuating prices, high input prices, household labor shortage, high cost of farm labor and lack of capital to buy inputs are the most important factors that hinder further commercialization of smallholder produce. However, in Meru South, high transport costs is seen as a contributing problem which is not the case in Mbeere district where farmers seems not to perceive transport as a major problem inhibiting them from accessing the markets. All the farmers seems not to consider lack of access to credit facilities as being a major factor despite them all indicating that lack of capital for inputs is among major constraints to their farming. The respondents in both study sites considers household related factors to be more constraining compared to market related ones. Though there ready markets exist for the farmers produce, the necessary efficient marketing links between the producer (smallholder farmer) and buyers in the market are lacking.

Farmers in both districts allocate more land to those crops that are deemed to have market unlike those that they have difficulty accessing the market. In addition, the more the land allocated to the preferred crop the more the mix in the application of the ISFM technologies in order to ensure increased yields for both home and market consumption. Other inputs such as high yielding varieties go hand in hand with the application of ISFM technologies resulting to intensification and specialization of crops. Farmers use a combination of different soil replenishing technologies when cultivating their crops in any given planting season. It is evident from the study that the smallholder farmers have knowledge and technical know-how on the application of ISFM technologies. However, these technologies are not continuously being practiced among smallholder farmers for a number of reasons. The main reason provided by smallholder farmers is their inability to see the value of the accrued benefits resulting from ISFM specifically the economic value from their crops. They cited also poor market returns for their produce caused by low prices offered especially by brokers. This is despite the fact that majority of the farmers in both study sites accrued their main income from sale of crops.

This study therefore went a notch higher in trying to bring in the aspect of marketing by linking it to the ISFM technologies introduced to the farmers. This is because soil fertility problems require a holistic approach in tackling it. Hence, the study picked on one aspect that is the social element in a bid to provide solutions to soil fertility degradation and natural resource management.

5.2 Recommendations

Based on the findings of this study, the following recommendations for immediate application and further research are made:

5.2.1 Recommendations for immediate application

Project developers and policy makers on soil fertility should recognize the need to equip smallholder farmers with not only practical soil fertility replenishing skills but also on marketing skills. These can be achieved by employing the entire Resource-to-consumption concept in their development agenda. The R-to-C concept extends the commodity chain to include investment in natural resource management, and specifically links natural resource management (NRM) to market opportunities. This is a new approach, which focuses on increasing household food security and producing crops that have an identified market opportunity. This differs from the conventional approach of trying to find markets for excess production at harvest time when commodity prices are at their lowest. More specifically, it links farmer participatory research, market opportunity identification, and development of technologies for integrated soil and nutrient management, with a focus on women and the poor.

There is need for farmers to organize themselves into smallholder marketing groups, organizations or societies. This will not only give them advantage of economies of scale but also boost their bargaining power while selling their produce. This can be achieved by project developers coming up with such initiatives like participatory agro-enterprise marketing for their target areas.

Farmers should be assisted in identifying suitable agro-enterprises. This can be achieved through equipping extension officers with the required knowledge on enterprise selection.

There is also a need for project developers on ISFM technologies to come up with, or include post harvest techniques in their agenda. This will ensure that the farmers do not concentrate only on increasing the yields but also on adding value to their harvested produce such as grading, drying hence their produce can fetch high prices. Therefore, with good returns from a selected agro-enterprise, farmers will tend to invest more on the natural resource management such as ISFM.

It is also important for government and NGOs as well as private sectors involved in soil fertility activities such as ISFM to invest on educating farmers in the area of marketing. This may facilitate investment of such innovation among farmers. Therefore, organizations working on soil fertility should not only focus on replenishing the soils but also incorporate aspects like commodity chains in their agenda.

5.2.2 Recommendations for medium and long-term research

The current study was mainly carried out from a farmer's perspective. It was carried out on a small scale due to limited resources and time within which this survey had to be finished. However, in future, a large sample of smallholder farmers who have participated in ISFM projects and those haven't should be incorporated to obtain deeper insights on how they market their produce and manage their natural resource base. This will provide a base in determining whether ISFM adoption and sustainability has any relationship with markets. Such information will be useful in determining whether there is need to integrate smallholder farmers into commodity chains or not.

It is believed that brokers are the main cause of poor returns on the farmers produce. A specific study on assessment on the economic implications on the farmers who sell directly to brokers and those who do not should be carried out.

5.2.3 Areas for further research

The study recommends further research to be conducted among small, medium and large scale farmers to provide a basis for comparisons on the aspects of natural resource management and marketing.

The study recommends further research on the role of ISFM technologies on livestock production. There is also need for further research on the competitiveness of the agro-enterprises using Resource-to-Consumption concept.

This research only sought to establish whether there is an interrelationship between ISFM and markets for produce. However, there is need for further research on the dynamics of markets in the bid to shed more on the marketing domain thus providing guidance for natural resource project developers to re-plan their goals and objectives accordingly.

5.3 Lessons learned

A number of lessons were learned from this study, which are important in accelerating agricultural intensification. A successful approach on scaling-up a successful approach is not the same as multiplying pilot-projects through reproducing the hard work within a small region to a much larger one. Farmer-to-farmer exchange and the organization of apprenticeships through trained local entrepreneurs may prove to be very efficient tools to disseminate information and strengthen capacities rapidly at a decreased cost. However, for effective scaling-up, more weight needs to be given to further introduction to commodity chain development, particularly to improve coordination between the various actors and stakeholders; and advocacy and lobbying for enabling environments at regional, national, and international levels through sustainable trade and producer associations.

Efficient integration of farmers in attractive commodity value chains will increase farm income and allow farmers to re-invest in environmentally sustainable production technologies, including the use of mineral fertilizers.

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APPENDIX 1: SAMPLE QUESTIONNAIRES FOR SMALLHOLDER FARMERS

APPENDIX 2: THESIS WORKPLAN

Activity	**2007**		**2008**				
	Aug –Oct	Nov	March	April-June	July - August	Sep-Oct	Nov
Research proposal writing & presentation							
Research tools design							
Pilot study							
Data collection							
Data analysis							
Thesis writing and presentation							
Thesis submission							

APPENDIX 3: FIELD BUDGET

Core Activity	Items/Participants	Cost (Ksh)	Cost in USD @Ksh.63
Pilot survey	Site visit Familiarization i) Accommodation and subsistence @Ksh.1000 for 1day ii) Transport for researcher @1000 (to and from site) iii) 1 research assistant being paid 250 per day 2daysxKsh.250	1,000 1,000 500	15.87 15.87 7.94
Data collection	i) Accommodation and Subsistence for researcher @Ksh.1500 for 18 working days ii) Transport for researcher @Kshs.1000x4 (4 trips) iii) 2 Research assistant each being paid Ksh.200x18days iv) Printing @Ksh20 per page for 10pages v) photocopying of questionnaires copies (150 copies at Kshs.20per copy) vi) 1 Focused group discussion in each of the 3 sites allowance for chief@ Ksh.500 lunch for 15 people Ksh.1000 total allowance for 3 sites (3xKsh.1500)	27,000 4,000 7200 200 3000 4500	428.57 63.49 114.29 3.17 47.62 71.43
Total		48400	768.25