FARMER GROUPS' CHARACTERISTICS' INFLUENCE ON THE SELECTION OF SOIL FERTILITY ENHANCEMENT TECHNOLOGIES IN EASTERN KENYA

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DECLARATION

This thesis is my original work and has not been presented for any degree in any other University or any other award.

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DEDICATION

To my dear husband Julius Mwebia, son Jesse Murimi and daughter Evelyn Wanja for their sacrifice, prayers, love and encouragement, throughout my studies.

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ACRONYMS AND ABBREVIATIONS

AEZ	-	Agro-Ecological Zone
ASARECA	-	The Association for Strengthening Agricultural Research in Eastern and Central Africa
a.s.l	-	Above Sea Level
CIAT	-	International Centre for Tropical Agriculture
CIG	-	Common Interest Group
ECA	-	East and Central Africa
FO	-	Farmer Organization
Ha	-	Hectare
HHH	-	Household Head
ICRAF	-	International Centre Research in Agroforestry
LM	-	Lower Midland Agro-ecological Zone
LR	-	Long Rains (March - May)
MS	-	Micro-Soft
NALEP	-	National Agriculture and Livestock Extension Programme
NGO	-	Non Governmental Organization
NRM	-	Natural Resource Management
SFE	-	Soil Fertility Enhancement
SNRT	-	Soil Nutrient Replenishment Technologies
SPSS	-	Statistical Package for Social Sciences
SR	-	Short Rains (October - December)
SSA	-	Sub-Saharan Africa
TLU	-	Tropical Livestock Unit
UM	-	Upper Midland Agro-ecological Zone

ABSTRACT

Declining soil fertility is a key problem in East and Central African sub-region and in the Central highlands of Kenya, which is compounded by the ever growing population that depends on the decreasing land sizes. Despite development of good and effective soil fertility enhancement (SFE) technologies, uptake by the farmers has remained low. Farmers' groups approach is one of the methodologies used for dissemination of SFE technologies but understanding of how this approach influences uptake of the technologies is limited. This study assessed the influence of farmer groups' characteristics on the technology application and also the influence that farmers' participation, trainings and socio-economic characteristics have on the selection of the technologies. The study was carried out in Mbeere South and Maara sub-counties in Kenya. Interview schedules were administered to farmer groups and individual farmers. Descriptive (frequencies, means, frequencies, percentages) and inferential (correlation and regression) statistics were performed on the data collected using SPSS software. The results showed that several key variables influenced groups' application of animal manure. These include; group size (p=0.019), the number of females in the group (p=0.027) and reason for applying manure (p=0.015). Variables that influenced application of fertilizer include; reason for applying fertilizer (p=0.043) and Tropical livestock unit (p=0.025). Variables that influenced application of a combination of manure combined with inorganic fertilizer include; group age (p=0.008), reason for applying the combination (p=0.022) and group gender (p=0.056). Household variables that influenced selection of manure include; HH size (p=0.001), benefits of manure (p=0.011), TLU (p=0.036), source of knowledge (p=0.023) and most effective teaching method (p=0.024). HH variables that influenced selection of fertilizer include; HHH education (p=0.033), land under food crops (p=0.012) and availability of on-farm income (p=0.012). HH variables that influenced the selection of a combined use of animal manure and inorganic include: HHH education (p=0.001), TLU (p=0.011) and availability of farm income (p=0.011). Among the total trainings (93.6%) that were conducted; 98.2% were soil fertility related, 24.3% were group dynamic related while 39.4% were production related. There was a significant (p=0.043) relationship between trainings and selection of a combination of manure + fertilizer. There was a significant (p=0.039) relationship between farmer participation and selection of a combination of manure + fertilizer. The information obtained from this study will be helpful to the groups themselves, researchers, policy makers, farmers' training designers and other stakeholders wishing to disseminate technologies in natural resource management programmes.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture is a source of livelihood in Sub Saharan Africa (SSA) and supports 2/3 of the population that is found in the rural areas (Toenniessen *et al.,* 2008). The gradual decline in the fertility of soils in SSA is a threat to the livelihoods (IAASTD, 2009). The depletion in soil fertility levels has been associated with an increase in population pressure, mining of soils by plants, decline in the fertilizer use and lack of control measures for soil erosion (Vanlauwe *et al.*, 2010; Cobo *et al.*, 2010).

The dissemination and adoption of soil fertility technologies has the potential of restoring the soil fertility levels for improved agricultural productivity (Nin-Prat *et al.*, 2011). However, there have been challenges and constraints faced in the dissemination, adoption and use of organic and inorganic source of nutrients in SSA (Nziguheba *et al.*, 2010). This short fall in the target has been linked to low investment in agriculture, insufficient capital levels, weak and ineffective extension systems (Kassie *et al.*, 2014).

Farmers' group is one of the approaches that have been used successfully to catalyze the participation of farmers as partners in research and development activities (Mwaura *et al.*, 2012; Mbowa *et al.*, 2012). Consequently it is possible to provide an effective technology transfer to specific groups (Reddy *et al.*, 2010). In addition, the farmer groups in SSA like the rest of the world act as a form of social capital (Mishra *et al.*, 2013). A farmers group is a community-based initiative that is meant to perform joint activities and to have an out-scaling effect on the community (Salifu *et al.*, 2010).

Farmer groups have increased productivity due to sharing knowledge among the participants in the groups (Liverpool and Winter-Nelson, 2010). However, these farmer groups in SSA face external and internal threats that impede on their effectiveness in dissemination of ISFM technologies (Afolami *et al.*, 2012). The threats may emerge from the management or leadership styles on one hand and from membership of the groups on the other hand (Fischer and Qaim, 2012). The group members may be the source of free riding, absenteeism, defaulters in payments and internal wrangling among the group members (Tanguy *et al.*, 2012). According to Liverpool-Tasie (2012) there are a lot of dynamics that operate within farmer groups in the developing world that have not been explored fully.

Farmer groups have been in existence in Central Highlands of Kenya for some time and have been used in the dissemination of agriculture technologies. For example, ISFM technologies in the Central Highlands of Kenya are aimed to improve on the soil fertility levels and consequently boost the agricultural productivity. Despite the presence of the ISFM technologies, there are a few members in the farmer groups in Central Highlands of Kenya who have adopted and used the ISFM technologies. In addition, the influence of farmer groups on the adoption and use of ISFM in the Central Highlands of Kenya is not understood. Therefore it was on this basis that the study was done to analyze the influence of farmer group characteristics on the selection of soil fertility enhancement technologies in Central Highlands of Kenya.

1.2 Problem Statement and justification

In the face of the low agricultural technology uptake, there has been increased interest in the use of farmer groups in their dissemination. It is hardly possible to find a development organization, research organization or government programme that does not attempt to work with community-based organizations in pursuance of rural development goals (Place *et al.*, 2004). This is because groups are community-based and their joint activities therefore have an outscaling effect on the community (Wennink and Heemskerk, 2006). However, studies on how rural collective action perform is a growing but still relatively small research area (Place *et al.*, 2002). Moreover, information on the role of farmer groups in dissemination and uptake of soil fertility management technologies remains scanty. This study therefore seeks to assess the influence of characteristics of farmers groups and their individual members' household characteristics on selection and application of SFE technologies in Mbeere South and Maara sub-counties.

1.3. Research Questions

The study sought to answer the following questions:

1. What is the relationship between farmer group characteristics (group age, size, frequency of meetings) and the application of soil fertility enhancement technologies?
2. What is the effect of trainings undertaken by farmers on their decision to select the soil fertility enhancement technologies?
3. What is the relationship between socio-economic characteristics (education levels, age, gender) of the farmers in farmer groups and the selection of soil fertility enhancement technologies?

4. How do farmers' participation in agricultural related group activities influence their decision to select soil fertility enhancement technologies?

1.4. Objectives

The study addressed the following objectives:

1. To assess the effect of farmer groups' characteristics (group age, size, frequency of meetings) on the choice of soil fertility enhancement technologies by individual members.
2. To determine whether farmers' trainings have an influence on their decision to select soil fertility enhancement technologies.
3. To assess the influence of socioeconomic characteristics (education levels, age, gender) of farmers on selection of soil fertility enhancement technologies.
4. To assess the influence of farmers' participation in agricultural related group activities on their selection of soil fertility enhancement technologies.

1.5. Research hypotheses

The study was guided by the following hypotheses:

1. There is a significant relationship between farmer groups' characteristics (group size, age, frequency of meetings) and the soil fertility enhancement technology application.
2. There is a significant relationship between trainings undertaken by individual farmers within the groups and their decision to select soil fertility enhancement inputs.
3. Farmers' socioeconomic characteristics (education levels, age, gender) positively influence groups' selection of soil fertility technologies.

4. Farmers' participation in agricultural related group activities positively influences their selection of soil fertility enhancement technologies.

1.6. Significance and Anticipated Output

The study outputs will be useful to the extension service providers, policy makers and other stakeholders working with or intending to work with natural resource management groups in the region. The farmer groups could also use the information to realize their areas of weaknesses and plan for group trainings and empowerment and this will provide a means to strengthen and guide the groups. Overall this information will give a focus on social capital (farmers groups) as an important player in the extension scene.

1.7. Conceptual Framework

Rogers (1983) diffusion of innovation model explains that adoption behavior is a mental process governed by a set of intervening variables; individual needs, knowledge about the technology, and individual perceptions about methods used in meeting those needs in a specific environment. Knowledge about the technology is a result of inter-personal communication or exposure (Hagerstrand, 1966). The farmers' groups are exposed to the technologies at the mother site, or at the group training venues. For groups to make decisions about the technologies, group characteristics (size, group age, frequency of meetings, common interest) and group structural structures (social net-works, rules, procedures) will need to come into play to influence the group's performance. The internal factors (education levels, wealth levels, gender, age) of the group members are crucial, since they determine group characteristics and structural structures. When groups perform, technology uptake increases hence improved soil fertility and food security (Figure 1.1).

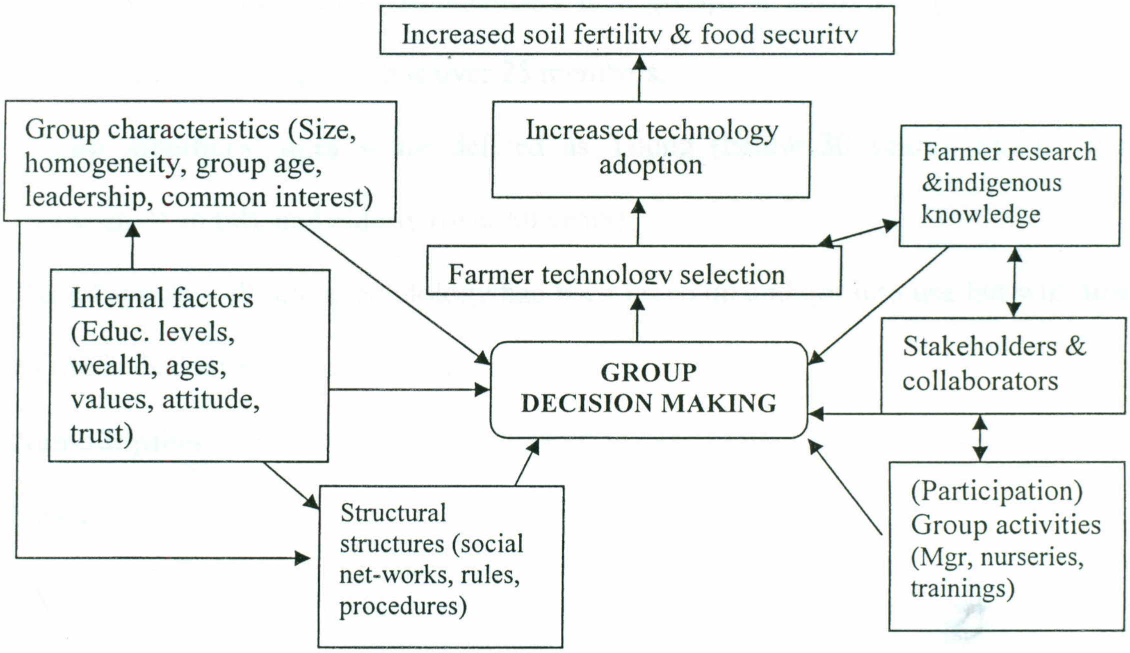

Figure 1.1: Conceptual framework on enhanced scaling up of SFE technologies through the farmers' groups' methodology

1.8 Definition of terms

Scaling up – it is a process of fast delivery of more quality benefits to more farmers over a large area, hence achieving widespread and lasting impacts.

Selection – The art of decision making made by the farmers either on their own or being influenced to pick and try research products on their farms.

Participation – Active involvement of the potential adopters of an integrated soil management technology in group activities, project field days, workshops, and other training sessions.

Farmer group – It is an informal, voluntary, homogeneous and self-governing association of 15-30 farmers formed at local level for the purpose of social, economic and sometimes spiritual benefit of all its affiliated individual members.

Level of application – The area allocated to the technology that the farmer decides to try and test on the farm.

Group size – The number of members in a group. A small group has up to 25 members, while a large one has over 25 members.

Group members' ages – are defined as Young (below 30 years), middle age (between 31 to 60), and elderly (over 60 years)

Dis-adoption – Where a technology had been taken up and got into use but with time its use is discontinued due to some reasons.

Non-adoption – Where a technology meant for adoption do not take off due to some reasons.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

Depletion of soil fertility, along with the concomitant problems of weeds, pests and diseases, is a major biophysical cause of low per capita food production (Zeleke *et al.,* 2010). According to Adewole and Anyara (2010) the average annual soil nutrient in Sub-Saharan Africa is on the increase with an impact on the GDP of these countries. In Sub-Saharan African countries, the mining of soils leads to N and K deficient soils with depletion levels as high as 85% and 76%, respectively (Cobo *et al*., 2010). The Land users are being encouraged to adopt soil fertility improvement technologies to improve on the soil fertility and ensure food security (UNEP, 2012). Scaling up the use of these technologies will be among the solutions to curb the low soil fertility problem. To achieve this, the researchers and the extension agents need to link the SFE technology development and demonstration stage with scaling up (Vellema and Hellmising, 2011). It has been widely recognized that most agricultural development programs lack a totality of approach, and also lack of suitable extension organizational characteristics which has become a barrier for transfer of appropriate new technology (Allahyari, 2008). In addition, there has been little analysis on why some participatory methods are more successful than others (Gonslaves *et al*., 2005). Studies exploring extension methodologies that are appropriate for scaling up are needed.

2.2. Scaling up of soil fertility management

There is a difference in the definition of the term scaling up as used in the context of agricultural development and technology dissemination (ASARECA, 2010). However, most of the definitions tend to focus on the aspect of impact of the technologies on the livelihoods of the recipients or adopters of the technologies (World Bank, 2012). The terms scaling up and out are increasingly being used to describe a desired expansion of beneficial impacts from agricultural research and rural development in terms of scale, scope and intensity behind new sustainable technologies (Coenen *et al*, 2010). Scaling up is the process of bringing successful practices from one farm to another through the use of field days and demonstrations. This process is accompanied by an efficiently increased socioeconomic impact of research output and successful dissemination of technologies (ASARECA, 2010; Seiwald, 2014). Scaling up often entails building institutional capacity in the community for promoting and sustaining the innovation and adoption process (ASARECA, 2010; World Bank, 2012).

The process of scaling up is viewed as a bridge between the research institutions and farmers or knowledge generation and practice (Vellema and Hellmising, 2011). Studies have shown that scaling up can reduce poverty and contribute to the Millennium Development Goals (MDGs) (World Bank, 2012). In addition, the scaling up has been shown to contribute to climate smart agriculture and enhancement of food security (Bogdanski *et al.,* 2010).

The process of scaling up is made up of transfer and expansion, which includes principles, processes and physical replication in different geographical locations

(World Bank, 2012). Innovation platforms have been shown to be one of the main channels in the process of up scaling of agriculture technologies (Kilelu *et al.*, 2013). Further, the success of the process of up scaling depends on innovations, policy and good governance structures (Eneku *et al.*, 2013).

The process of up scaling may involve the judicial use of organic and inorganic fertilizers, the use of ISFM technologies and hedgerows in the small holder farms, soil erosion control technologies (Kato e*t al*., 2011; Eneku *et al*., 2013; Lawal *et al*., 2014; Chapagain and Gurung, 2014). The results of up scaling has been shown to include a substantial increase in the soil fertility and crop yields, higher crop vigour and cultivars and reduction in the soil erosion (Agegnehu, 2014).

There are several constraints to the process of up scaling of the technologies in agriculture (Eneku *et al.,* 2013). The main constraints to the up scaling of agriculture technologies include inadequate fertilizer supply, inadequate labour, poor knowledge of the ISFM technologies, poor transport, low producer prices and high cost of production (Lawal *et al.,* 2014). In addition lack of labour, lack of livestock and small pieces of land (Kato *et al*., 2011). The constraints to up scaling leads to further soil degradation that limits productivity and leads to further losses in the soil fertility (Zeleke *et al*., 2010; Agegnehu, 2014).

Effective monitoring and evaluation is essential for successful uptake of SFE technologies (MoA and MoD, 2010). There is a need to develop soil management practices that are sustainable and adoptable by the small scale farmers. Studies linking scaling up and the methodologies used for technology dissemination are necessary.

2.3. Farmer Groups

Scaling up methodologies has been successfully implemented through group contact methods (Lapple and Van Rensburg, 2011). Under this category, the rural people or farmers are contacted in a group which usually consists of 20 to 25 persons (Adong *et al.*, 2013). These groups are usually formed around a common interest or objective (Salifu *et al.*, 2010; Davis *et al.*, 2010). The methods involve a face-to-face contact with the people and technical recommendations are delivered and finally, there is room for deciding the future course of action. Group targeting encourages a wider community participation (planning /implementation) in a particular project (Asante *et al.*, 2011). This method is easy to facilitate and bring various stakeholders together for a common purpose. It is also easier to disseminate development ideas/technologies and information within a group. It encourages networking and ensures group empowerment (Adong *et al.*, 2013), and also allows for effective and efficient utilization of available resources and mobilizes beneficiaries fast (Salifu *et al.*, 2010). The disadvantage is that decision making is a long process and the risk of taking group interest as homogeneous ignoring diversity of interest is wide. Groups may also impose uniform solutions, forgetting that needs are dynamic and influenced by multiple factors (Mennon *et al.*, 2012). Group apathy, lack of transparency and some members exploiting others due to their social and leadership status are some of the risk factors (Davis *et al.*, 2010).

The structural adjustment programmes (SAPs) introduced in the 1980's and 1990's lead to the privatization of many services in the agriculture sector in SSA (FAO, 2012). The result of the changes in the agricultural sector was that farmers were left exposed to exploitation by traders and middlemen (Hill, 2011). Farmer groups are an innovation that has emerged to bridge the gaps and protect farmers from exploitation in SSA countries and the world.

Kenya like other countries in the world has recognized the important role of farmer groups in the dissemination of agriculture technologies (Mennon *et al.,* 2012). Consequently, the Kenya government with the help of donor agencies initiated the National Agriculture and Livestock Extension Programme (NALEP), which was a popular extension programme in Kenya, where common interest groups (CIGs), were made up of farmers with similar lines of production and interests, Republic of Kenya (2011). These groups were the focal points of extension services, where members defined the type of extension they needed or the linkages that would be of benefit to them, and they also had a big impact on the community since some became powerful farmers' organizations which gave a voice to the small scale farmers to communicate with extension providers and other stakeholders who were either public or private (Mutisya *et al.,* 2010; RoK, 2011).

When donors, government or any other development agencies initiate soil fertility initiatives in an area, groups become very good targets, and especially if natural resource management initiatives are among their activities. The choice to work with these groups is because of their governace structures. Most social networks are found in groups (MoA and MoLD, 2010), and where interaction between actors is greater and groups are also able to provide social controls and social capital (Farnworth and Obuya, 2010). Groups will also allow farmers to obtain new technologies, benefit from economies of scale, enter into stable relationships with suppliers, and set rules for natural resource management (Magrete *et al*., 2010). The farmer groups play an important role in sustainable soil management and may influence policy related to climate change, soil topography and extension services (Wollni *et al.,* 2010). For instance, through NALEP CIGs, the Lake Victoria Development Program since July 2000 collaborated with ICRAF to carry out natural resource management in the seven lake basin districts which include; Kericho, Kisii, Nandi, Nyamira, Nyando, Siaya, and Vihiga districts (Hill, 2011) and disseminated and transferred agroforestry technologies from plot level to farm, catchment, and finally basin level (Alterra, 2010).

There is evidence that farmer groups are efficient in marketing of agricultural commodities (Mennon *et al.,* 2012; Adong *et al.,* 2013). The performance of farmer groups would need development and strengthening of human and social capital (Halkos and Jones, 2012). The farmer groups are also able to provide skills, training in marketing and entrepreneurship, and linkages to other chain actors and final markets (Mennon *et al.,* 2012; Ondieki-Mwaura *et al.,* 2013). These groups can therefore be key to technology scaling up by ensuring that their members adhere to the rules and constitutions set by the members (Mwaura *et al.,* 2012; Larsen and Lilleor, 2014). These groups have also been seen to have potential in disseminating the SFE technology trial results because of their close networks with other farmers' groups and their effectiveness as extension agents, being farmers themselves (Larsen and Lilleor, 2014; Mwaura, 2014). However, studies focusing on farmer groups as potential scaling up instruments in the community are needed.

2.3.1. Factors that influence success of farmers' groups

Farmers' groups usually help farmers to better exploit existing resources through the economies of scale (Salifu *et al.*, 2010; Asante *et al.,* 2010). The success of these groups is measured through their performance in terms of profitability, poverty reduction, access to extension and credit services, level of investments and communication among the group members (Mennon *et al.*, 2012; Milla *et al.*, 2014;). The rate and the extent of adoption of technologies that are introduced into a group is also a measure of the performance of the groups (Alufah *et al.,* 2012). Farmers' groups and community based organizations have been successfully used in Western Kenya to promote improved fallows and in Central Kenya to scale up soil and water conservation technologies (Odendo *et al.*, 2010; Alufah *et al.*, 2012).

The growth of farmer groups and adoption levels can also be used in measuring the performance of farmer groups (Davis *et al.*, 2012). There are several studies that have been done to analyse the factors that affect the decision of farmers to participate in farmer groups (Faroque and Takeya, 2009; Ali *et al.*, 2007; ICRAF, 2012). There are studies that have attempted to analyses the factors that influence the adoption of different ISFM technologies (Zhou *et al.,* 2010; Alufah *et al.*, 2012; Barungi *et al.,* 2013; Ngwira *et al.,* 2014).

The farmer perception affects the performance of farmer groups since it has a direct effect on the adoption or rejection of new technologies (Barungi *et al.,* 2013). Some of the external factors are supportive extension, good infrastructure, positive market forces conducive policies and research agents (Ngwira *et al.,* 2014). The access to credit and training of farmers or group members has an effect on the performance of the farmer groups (Gwandu *et al.*, 2010; Mustafa-Msukwa *et al.*, 2011; Alufah *et al.*, 2012). The size of farmers groups has been reported to have an effect on the performance of the groups, for example in the case of farmer field schools (Murage *et al.,* 2012).

On the other hand, aspects of social capital which include: relations of trust, corporation, norms/sanctions, group cohesion and group net-works have been reported to influence the group performance (Magreta *et al*., 2010). The broad scope of group activities has been identified as one of the factors which are key to group sustainability (Gebre and Weldemariam, 2013). The presence of small sized groups, clearly defined boundaries, shared norms, past successful experiences, appropriate leadership, interdependence among members, heterogeneity of endowments, homogeneity of identities/interests and low levels of poverty contribute to group success (Odendo *et al.,* 2010; Mustafa-Musukwa *et al.,* 2011; Mutuma, 2013). The social capital can also be in the form of structural e.g. revolving funds or 'merry go round' and cognitive social capital (Badbury, 2006). The resources upon which individual draw their livelihood is called the social capital.

In Kenya, farmer group extension approach seeks to empower motivated farmers to enhance and diversify the productivity/profitability of their agroforestry and farm systems, strengthening their capacity to seize market opportunities (Alufah *et al.,* 2012; Mutuma, 2013). Groups provide a means of collective action for farmers, providing resources such as credit, labor, and information (Alufah *et al.,* 2013; Korir *et al.,* 2015). Groups allow farmers get new technologies, benefit from economies of scale, enter into stable relationships with suppliers, and set rules for natural resource management (Ondieki-Mwaura *et al.,* 2013). The Studies that have been reviewed in this section have examined performance at the group level based on specific parameters. However, there are few studies that have attempted to assess the influence of group characteristics on selection of SFE technologies.

2.3.2. Advantages of Farmers' Groups or Farmers' Organizations

There are studies that have analysed the benefits of participating in farmer groups. The reasons that have been identified for the participation in farmer groups include access to credit and extension services by the farmers (Salifu *et al.,* 2010; Davis *et al.,* 2010; Adong *et al.,* 2013). The other advantage of participation in the farmer groups include increase in yields, profitability and access to technologies (Carr, 2010; Milla *et al.,* 2014; Larsen and Lilleor, 2014). The use of farmer groups is instrumental in the rural areas for the advocacy by farmers in research related and for policy issues (Mwaura, 2014).

Farmer organization and collective action are often seen as key factors in enhancing value addition, access to credit and markets by small holder farmers (Adong *et al.,* 2013). They have also been identified as effective channels for social participation, skills and development among farmers (Mennon *et al.,* 2012). Therefore, a strong emphasis is placed on the promotion of farmer associations in order to facilitate farmer access to inputs, credit, output markets, market research, and technical training and to improve coordination within the smallholder sector (Alufah *et al.,* 2012; Barungi *et al*., 2013).

Members in a group can monitor each other where necessary and improve on the level of trust within the farmer groups (Halkos and Jones, 2012). Policy analysts and advocates also emphasize roles of farmer organizations in improving smallholders' access to services (Magreta *et al.,* 2010). The farmer groups are seen as an essential contact point between government agencies and contract firms (Ondieki-Mwaura *et al.,* 2013).

2.3.3. Challenges in Farmer Groups

The interaction between farmers has been shown to lead to the adoption of technologies (Mwaura, 2013; Gwandu *et al.*, 2014). However, the cooperation within farmer groups is challenged by several factors, which may impede on the performance of the farmer groups. Collective action involves individuals cooperating to solve a shared problem or set of problems by establishing and implementing rules to promote common interests and action, and to prevent 'free riding'. Agreeing and implementing these rules is a major challenge especially with larger and more heterogeneous farmer groups and where the benefits of collective action are uncertain, not clearly limited to or identified with organization membership, and of varying importance to members' livelihoods (Ali *et al.,* 2007).

The active involvement of farmer organization members in different roles in the organizations also poses 'collective action' difficulties (Lickerman, 2013). When structural forms and cognitive forms of social capital are broken, group members lose confidence in the system, disobey group rules, loose trust with the leadership and develop negative attitude towards the group. When internal factors (education levels, wealth levels, age differences) are affected, there is financial mismanagement within the group and members loose group commitment for lack of individual benefits. According to Hans *et al.* (2014) external factors can be a source of social capital but may also have a problem, the group can easily loose direction and may even disintegrate especially if it is in its formative stages. According to Rathgeber (2011), as groups take on new projects they drop others and women will tend to join groups in order to purchase household items or for social insurance, while men will join mainly to access markets.

The soil fertility projects will therefore tend to be abandoned especially if the technologies are not multipurpose, easy to adopt, have no quick financial returns, are expensive and labour intensive. This makes demands on farmers' governance structures. These structures must fit members' abilities and requirements for participation in the farmer groups to avoid internal or external conflicts (Ali *et al.*, 2007). Actions that increase the capacity and confidence of communities and farmer groups can help provide the pre-conditions for sustainable agricultural development (Alufah *et al.,* 2012; Barungi *et al.,* 2013). However, it should not be assumed that community groups are homogenous, democratic or free of gender bias (Davis *et al.*, 2010; Carr, 2010; Barungi *et al.,* 2013). Studies to assess the influence that the socio-economic characteristics of the group members have on the selection of soil fertility enhancement inputs are needed.

CHAPTER THREE

3. 0 MATERIALS AND METHODS

3.1 Description of study Area

The study was carried out in Mbeere South and Maara sub counties (Figure 3.1). These sub counties were selected because research and dissemination on soil fertility had been done in the area. Mbeere South lies in the Agro-ecological Zone (AEZ) Lower midland 4 and 5 (LM 4 and LM 5), with an altitude of about 800m above sea level (Jaetzold *et al.*, 2006). The average rainfall is between 600-800 mm per year, in a bimodal regime, where long rains come from mid March to June and the short rains from late October to December. The annual mean temperature is between 21.7 to 22.5°C. The soils are predominantly Ferralsols and Acrisols (Jaetzold *et al.*, 2006), and the predominant land uses are dry land farming and livestock production.

Maara sub-county lies in the Agro-ecological Zone (AEZ) Upper Midland (UM2-UM3) (Jaetzold *et al.*, 2006) on the eastern slopes of Mount Kenya, with an altitude of 1500 m above sea level. It receives an average rainfall of 1200-1400 mm per annum with a bimodal regime where long rains come from March to June and short rains from October to December. The mean temperature is 20^0C. Two cropping seasons are experienced in a year. The district is predominantly maize/coffee growing zone with some dairy enterprises, with smallholdings ranging from 0.1 to 2 ha and an average of 1.2 ha per household (Jaetzold *et al.*, 2006). The soils are mainly humic Nitisols.

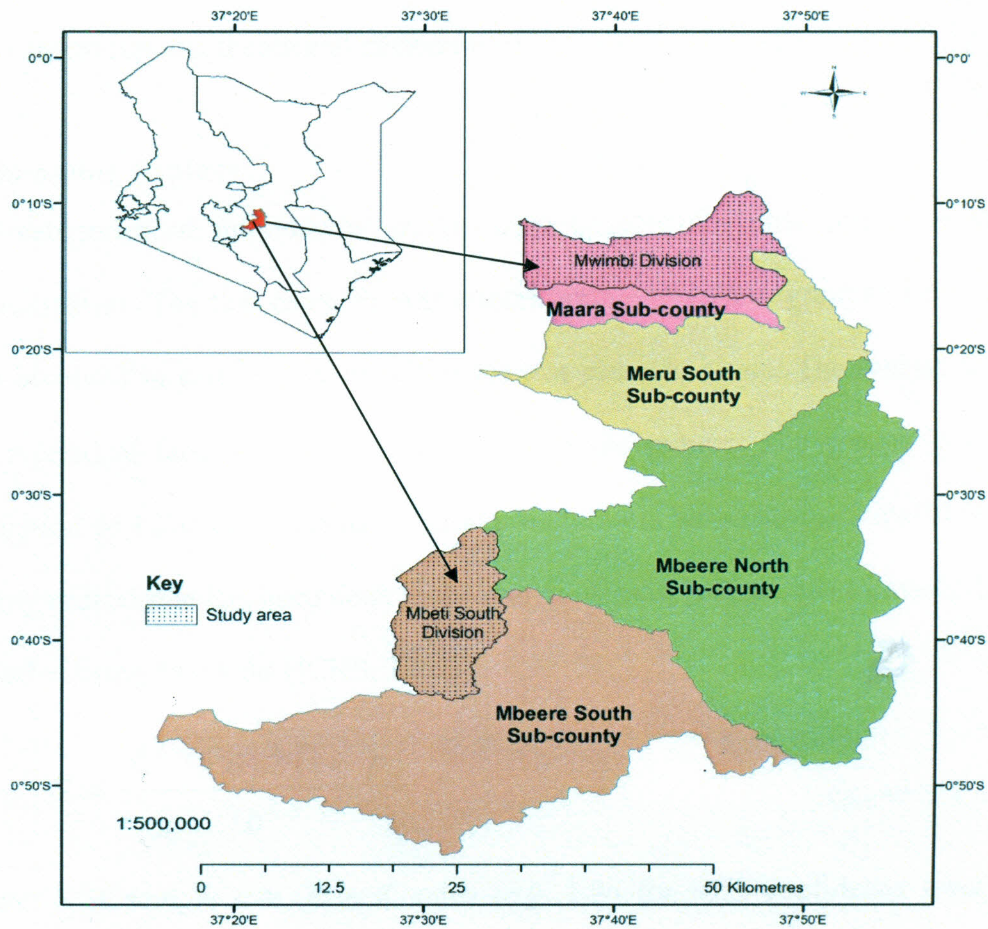

Figure 3.1: Map showing study area where data was collected. Source: Author (2015)

3.2 Research design

Primary data was collected through face to face interviews with farmer groups and individual farmers who had participated in a soil fertility project for two years. The study aimed at collecting information from the farmers groups and individual farmers who were members of the groups on the group characteristics and household factors for enhanced uptake of various soil fertility management technologies. Both primary and secondary sources of data were used. Primary sources of data were questionnaires and interview schedules while secondary sources included journal articles, Government reports, theses and dissertations.

3.3 Sampling strategy

Two categories of interviewee groups were targeted for data collection through questionnaires. The first category was a total sample of farmer groups (60), who had been involved in soil fertility activities for two previous years. The second category was individual farmers who were members of the groups. The groups' household population of 1200 was derived by listing the farmers who had participated in a soil fertility project that had been done in the region. A sample size of 218 households was arrived at using Equation 1(CRS, 2007).

$$S = \frac{Z^2 * (p) * (1-p)}{c^2} \qquad \text{Equation 1}$$

Where: S is sample size, Z is Z value (e.g. 1.96 for 95% confidence level), P is percentage of picking a choice, expressed as decimal (0.5), C is confidence interval, expressed as a decimal (0.098= ±9.8%). Individual farmers were randomly selected from the single gendered groups. Stratification based on gender was also put into consideration to ensure proportionate representation of both genders from the mixed gendered groups.

3.4 Pre-testing the research tools

A pre-test was done before the main survey. This was conducted in order to check for face, content and criterion validity of the farmers' interview schedule and the group questionnaires. It also helped to ascertain the amount of time needed to administer the tools. A sample of 7 farmers and two farmer groups from each site were randomly selected and interviewed.

3.5 Data collection

The data collected from both individual farmers and farmer groups included: (i) Demographic characteristics, (ii) group characteristics, (iii) group activities, (iv) group trainings, (v) soil fertility and technologies (Questionnaires Appendix i and ii).

3.6 Data analyses

Data cleaning and close examination was done to ensure completeness and consistency in the questionnaires. The questions were coded, managed and stored in MS Excel. SPSS, version 16 software, was used for data analyses. Descriptive statistical analysis was applied, involving the use of means, frequencies, percentages, standard deviation. For categorical variables, cross tabulation was carried out while for quantitative variables, Pearson correlation was done. In the regression analysis, the group characteristics and the household and socio-economic variables were independent (explanatory) variables while the dependent variables were the farmers' groups' technology application and individual farmers SFE technology selection (Table 3.1 and 3.2). Results were presented in form of tables.

Table 3.1: Definition of study variables influencing the groups' application of animal manure, inorganic fertilizers and manure + fertilizers technologies in Mbeere South and Maara sub-counties in the central highlands of Kenya

Variables	Definition
Dependent variables	
Application (Manure, inorganic fertilizer, manure + fertilizer)	0 Not applied 1 Applied
Independent variables	
Group age	Continuous variable
Group size	0 Small 1 Large
Group gender	1 Male 2 Female 3 Mixed
Educated group	0 Not educated 1 Educated
No. of educated members of the group	
Ages of group members	0 Young 1 Old
Frequency of group meetings	1 Weekly 2 Fortnightly 3 Monthly
Meeting venues	0 Members' homes/farms 1 Public places
Tropical Livestock Unit (TLU)	Continuous variable
Common agenda during group meetings	1 Planning for trainings 2 Contributions / Benefits 3 Group investments
Number of males/females in the group	Continuous variable
Prompt for group formation	0 External influence 1 Internal influence
Qualification of group membership	1 Character / behaviour 2 Family relations 3 Ability to contribute financially
Reason for applying animal manure	1 Soil fertility & structure 2 High cost of fertilizers 3 Availability
Reason for applying inorganic fertilizer	1 Ease of application 2 Fast growth & maturity 3 High yields
Reason for applying a combination	1 High yields 2 Soil fertility & structure 3 Fast growth & maturity
Number of beneficiaries from agricultural activities	Continuous variable
Rating of participation in group activities	1 Fair 2 Good 3 V. good

Table 3.2: Definition of study variables influencing the farmers' selection of animal manure, inorganic fertilizers and manure + fertilizers technologies in Mbeere South and Maara sub-counties in the central highlands of Kenya

Variables	**Definition**
Dependent variables	
Selection of animal manure, inorganic fertilizer and manure + fertilizer	0 No 1 Yes
Independent variables	
HH head gender	1 Male 2 Female
HH head age	Continuous variable
Education	0 Not educated 1 Educated
Number of months spent on the farm	Continuous variable
Benefits of animal manure	1 Fertile soil 2 High yields 3 Water retention
Participation in group activities	0 No 1 Yes
House hold size	Continuous variable
Total land for the HH	Continuous variable
Total HH land with food crops	Continuous variable
Tropical Livestock Units (TLU)	Continuous variable
Number of donkeys	Continuous variable
Number of groups farmer belongs to	Continuous variable
Land with/without title deed	0 Without title 1 With title
Full / part-time farmer	0 Part-time 1 Full-time
Any on-farm income	0 No 1 Yes
Benefits of fertilizer / combination	1 Fertile soil 2 High yields 3 Early maturity
Source of knowledge of manure, fertilizer and manure + fertilizer	1 Extension 2 Researchers 3 Other farmers
Most effective method to teach manure, fertilizer and manure + fertilizer	1 Demonstrations 2 Meetings 3 Media

For logistic analysis, various factors were regressed upon the dependent variable "group membership" in a binary logistic model. Such models are used when response variables are binary; that is, they have only two possible outcomes (Agresti & Finlay, 1997). The generic terms for the two possible outcomes are success and failure, and the "odds" equal the probability of success divided by the probability of failure (Table 3.1 and 3.2). As the outcome (in this case, participation in a group) increases from 0 to 1, the odds increase from 0 to infinity. This model tests the probability that the independent variable X has no effect on the dependent variable Y (Agresti & Finlay, 1997). The independent variables consisted of both categorical and continuous variables and were coded accordingly (Table 3.1 and 3.2). In the logistic regression model, B is the estimated coefficient with standard error S.E. The ratio of B to S.E., squared, equals the Wald statistic. If the Wald statistic is significant (i.e less than 0.05) then the parameter is useful to the model. Exp(B) is the predicted change in the odds for a unit increase in the predictor. When Exp(B) is less than 1, increasing values of the variable corresponds to decreasing odds of the event's occurrence and when Exp(B) is greater than 1, increasing values of the variable correspond to increasing odds of the event's occurrence.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-demographic Characteristics of the Groups

In the study area, 80% of the groups were small and 20% were large in size, while 66.7% were of mixed gender, 28.3% female and 5% were male gendered (Table 4.1).

Table 4.1: Socio-Demographic characteristics of farmer groups in Mbeere South and Maara sub-counties

Parameter		**Frequency**	**Cumulative percent**
Group size	Large	48 (80)	80
	Small	12 (20)	100
Group gender	Male	3 (5)	5
	Female	17 (28.3)	33.3
	Mixed	40 (66.7)	100
Group education level	Not educated	26 (43.3)	43.3
	Educated	34 (56.7)	100
Ages of group members	Young	25 (41.7)	41.7
	Old	35 (58.3)	100
Meeting venues	Group venue (farm)	17 (28.3)	28.3
	Members' homes	7 (11.7)	40
	Public places	36 (60)	100
Frequency of group meetings	Weekly	16 (26.7)	26.7
	Fortnightly	13 (21.6)	48.3
	Monthly	31 (51.7)	100
Qualification for joining group	Character / behaviour	30 (50)	50
	Family relations	3 (5)	55
	Ability to contribute financially	27 (45)	100
Prompt for group formation	Internal issues	15 (25)	25
	External influence	45 (75)	100
		Mean	**SD**
Group age (years)		6.9	4.7
Number of males in the group		6.5	9.0
Number of females in the group		15.6	9.0
Tropical Livestock Unit (TLU)		1.9	0.8
Number of beneficiaries from agricultural activities		22.8	19.4

Values on parentheses are in percentages

A majority of the groups (56.7%) were educated while 43.3% of the groups were not. Education was determined by a majority of the group members having completed secondary school. A majority (58.3%) of the groups had old farmers (Over 40 years), while 41.7% of groups had young farmers. Most (60%) of the groups met in public places as opposed to 28.3% who met in their group venues (group farms) and 11.7% in individual member's homes respectively. A majority of the groups (51.7%) met monthly as opposed to 26.7% who met weekly and 21.6% met fortnightly. A majority (50%) of groups qualified their members to join the group by assessing their character, while 45% used the ability to contribute financially and family relations respectively. Most (75%) of the groups were prompted to form by their internal issues while 25% were prompted by external issues. The average years that the groups have been in operation (group age) is 6.9 years. The average number of males in the groups was 6.5, while 15.6 was the average number of females in the group. The groups had an average of 1.9 tropical Livestock Units (TLU), while the average number of beneficiaries from agricultural activities in their groups was 22.8.

4.2 Socio-demographic Characteristics of the Household Respondents

Table 4.2: Socio-Demographic characteristics of Households in groups in Mbeere South and Maara sub-counties

Parameter		Frequency	Cumulative percent
HHH gender	Male	128 (58.7)	58.7
	Female	90 (41.3)	100
Full/Part-time farmer	Part-time	31 (14.2)	14.2
	Full time	187 (85.8)	100
Main occupation	Farming	158 (86.2)	86.2
	Business	13 (6.0)	92.2
	Formal employment	17 (7.8)	100
Married	No	10 (4.6)	4.6
	Yes	208 (95.4)	100
Education	No	123 (56.4)	56.4
	Yes	95 (43.6)	100
Land	Without title	80 (36.7)	36.7
	With title	138 (63.3)	100
Available farm income	No	24 (11)	11

Yes	194 (89)	100
	Mean	**SD**
Months spent on the farm per year	8.6	2.8
HHH age (years)	50.3	12.7
HH size	5.0	2.2
Number of groups one belongs to	1.7	0.9
HH total land	4.2	4.3
HH land under food crops	2.1	2.0
HH Tropical Livestock Unit (TLU)	2.5	2.3

Values on parentheses are in percentages

In the study area, 58.7% of the household heads were male and 41.3% were female while 85.8% of the HHHs were fulltime farmers and 14.2% were part-time farmers (Table 4.2). A majority (95.4%) of the HHHs were married while 4.6% were not. Most (56.4%) of the HHHs were educated (completed secondary school), while 43.6% were not. A majority of the HHHs did farming as their main occupation and most (89%) of them had available farm income. The average age of the HHHs was 50.3 years with an average HH size of 5 persons and the number of groups one belonged to was 1.7. The average HH total land was 4.2 acres, while the average area under food crops per HH was 2.1 acres. The average Tropical livestock Units (TLU) was 2.5 within the study area.

4.2 The effect of farmer groups' characteristics on the application of SFE technologies

4.2.1 Group characteristics influencing the use of animal manure in Mbeere South and Maara sub-counties

Results of univariate analysis of group characteristics influencing the application of animal manure showed that two variables were associated with use of manure. These variables were reason for applying animal manure (p=0.015) and number of females in the groups (p=0.027) (Table 4.3). However, group size, group age and frequency of group meetings did not have a significant association with the application of animal manure (Table 4.3).

Table 4.3: Group characteristics influencing application of animal manure in Mbeere South and Maara sub-counties

Group characteristics		**Group Applied Manure 2010/11**		**χ^2 P value**
		Not Applied	**Applied**	
Group size	Small	14.0 (29.2)	34.0 (70.8)	0.307 NS
	Large	5.0 (41.7)	7.0 (58.3)	
Ages of group members	Young	9.0 (36.0)	16.0 (64.0)	0.370 NS
	Old	10.0 (28.6)	25.0 (71.4)	
Frequency of the group meetings	Weekly	2.0 (12.5)	14.0 (87.5)	0.157 NS
	Fortnightly	5.0 (38.5)	8.0 (61.5)	
	Monthly	12.0 (38.7)	19.0 (61.3)	
Reason for applying animal manure	Soil structure & fertility	3.0 (60.0)	2.0 (40.0)	0.015*
	High cost of fertilizer	11.0 (47.8)	12.0 (52.2)	
	Availability	5.0 (15.6)	27.0 (84.4)	
		Mean	**Mean**	**t-test**
Number of males in the group		8.7	6.5	0.492 NS
Number of females in the group		11.5	18.3	0.027 *
Group age		6.1	7.3	0.323 NS
Tropical Livestock Unit (TLU)		1.8	2.0	0.522 NS

N=60, *association significant at $\alpha = 0.05$

The results indicate that most of the members of groups applied animal manure across all group ages. Almost equal number of small and large groups applied animal manure. The mean number of males in the groups that applied animal manure was almost equal to the groups that did not apply animal manure (Table 4.3). This implies that neither the ages of the groups nor their sizes influenced the application of manure. This is similar to results of a study by Odendo *et al.* (2010) who reported that group age did not have any significant effect on the adoption of organic fertilizers but had a positive effect on the adoption of mineral fertilizers. This is also contrary to Place *et al.* (2002) who reported that age of a group as a unit and changes in purpose over time affect group success.

The reason for selecting manure significantly (*p*=0.015) influenced the application of animal manure. This implies that availability of manure caused an increase in the application of animal manure. This could be because most farmers have one or more types of livestock which becomes a farm level source of manure. This agrees with Mugwe *et al.* (2009) whose study in the central highlands of Kenya showed that livestock keeping for milk and manure production is a major enterprise in this region and therefore manure is easily available. The perception and attitude of farmers regarding manure has an effect on the adoption of manure (Odendo *et al.,* 2010). At the same time, farmers use crop residue after harvesting to add as animal shed beddings, which later rot and add to animal manure. The farmers' preference for manure could also be attributed to the perception that increases in soil fertility resulted in high yields and better leaf colour (Barungi *et al*., 2013). Animal manure was also reported by Kato *et al*. (2011) as the mostly used organic inputs. If manure, crop residues and composted organic materials from household waste or other sources are ploughed back into crop- growing areas, instead of being burnt, the need for inorganic fertilizers will at least be reduced (Mustafa-Msukwa, 2011).

The results of the Logit model are presented in (Table 4.4). The model was significant at $p<0.01$ and correctly predicted 78.3% of both that applied and those that did not apply animal manure. Group size ($p=0.019$), frequency of group meetings ($p=0.050$) and the number of females in the group ($p=0.008$) were significant in explaining the application of animal manure in Mbeere South and Maara sub-counties (Table 4.4).

Table 4.4: Group characteristics influencing application of animal manure technology by groups in the Mbeere South and Maara sub-counties

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
Group age	0.131	0.083	2.497	0.114	1.140
No of females in the group	0.197**	0.074	7.045	0.008	1.218
Frequency of group meetings	-0.920*	0.470	3.834	0.050	0.399
Participation rate	1.068	0.665	2.575	0.109	2.908
Tropical Livestock Unit (TLU)	0.120	0.511	0.056	0.814	1.128
No of males in the group	0.076	0.061	1.583	0.208	1.079
Group size	-3.898**	1.657	5.535	0.019	0.020

N=60, **Significant at 5% probability level, *Significant at 10% probability level

Group size negatively (β= -3.898, p=0.019) influenced application of animal manure (Table 4.4). This implies that the smaller the group sizes the higher the likelihood of using animal manure. This is probably because members of smaller groups are able to interact and share closely as opposed to members of large groups. According to Alufah *et al.* (2012), there is a significant relationship between group organizations and the adoption of soil improvement technologies. The size of a group affects the performance in terms of communication and management structures (Ngwira *et al.*, 2014). Large groups on one hand gain a wide range of experiences due to numbers and are likely to include persons from various farmer categories. On the other hand, such large groups are sometimes characterized by a less intensive exchange of experiences among themselves; they tend to be more subject to social problems, free riding and are often difficult to manage, therefore requiring strong leadership (Magreta *et al.*, 2012).

The frequency of group meetings negatively (β= -0.920, p=0.050) influenced application of animal manure (Table 4.4). This implies that the less the frequency of the group meetings, the more the likelihood of groups applying animal manure. That means that groups that meet monthly are more likely to adopt soil fertility technologies more than those that meet weekly.

The reason for this could be that agricultural activities that involve soil inputs application are normally seasonal, and monthly meeting can address agricultural issues such as soil fertility replenishment which is once a season activity. On the other hand, most groups that meet weekly address resource issues such as merry-go-round, household items and credit issues. Where groups have accessed loans from their revolving fund or from outside, and repayments are mostly weekly or fortnightly, forcing the group to meet for loan repayment. Davis and Negash (2007) reported that the "poor" are the ones participating in many of the groups, and that they naturally come together because they have needs and togetherness may marginally reduce the resource poverty they experience. Less frequent meetings allow group members to assist on each other's farms and this provides a learning experience forum for each one of them. This agrees with Cramb (1999) who reported that farmers group themselves work on each other's farms on a rotation basis. This not only assists in labour sharing but also hastens adoption of SFE technologies.

The number of females in the groups significantly (β= 0.197, p=0.008) influenced application of animal manure (Table 4.4). This implies that an increase in the number of women in the groups increased the likelihood of application of animal manure. Explanation for this could be because manure is a resource that is easily available at the household level and hence does not require cash. Women have a higher likelihood of joining farmer groups compared to men due to the benefits that are associated with membership in such groups (Milla *et al*, 2014). However, Women are resource constrained and may not be able to raise the registration fees or own land that may be used as collateral in farmer groups (Rathgeber, 2011). Therefore women are likely to adopt new technologies that do not require a lot of financial input or resources.

Kato *et al.* (2011) noted that processing and application of traditional organic materials such as crop residues and organic manure are labour intensive. Women are the main labour providers on the farms (Rathgeber, 2011). At the same time, women are known to talk a lot, share a lot and also influence each other easily. Manure application is not a knowledge-intensive exercise and therefore women could apply it with no problem as long as a demonstration on application is done. This agrees with Barungi *et al.* (2013) who reported that women who had less education than men excelled in the uptake of soil fertility replenishment technologies as long as explanations were given in the simplest terms possible. Less educated women were found to excel in adopting new technologies as long as explanations were provided in simple language and that this could explain why women were enthusiastic of soil fertility replenishment technologies and decided to adopt such techniques (Gwandu *et al.,* 2014). That means that once they understand and have the numbers, they can influence each other in to adoption (Gwandu *et al.,* 2014). However, a study by Mustafa-Msukwa *et al.,* (2011) showed that the adoption of compost manure may not depend on the availability of women's labour.

4.2.2 Group characteristics influencing the application of inorganic fertilizers in Mbeere South and Maara sub-counties

Results of univariate analysis of group characteristics influencing the application of inorganic fertilizer showed that Tropical Livestock Unit (TLU) (p=0.025), Group meeting venues (p=0.039) and the reason for applying inorganic fertilizer (p=0.043) were significant in explaining the application of inorganic fertilizer (Table 4.5). However, group size, group age and frequency of group meetings did not have a significant association with the application of fertilizer (Table 4.5).

Table 4.5: Group characteristics influencing application of inorganic fertilizers in Mbeere and Maara sub-counties

Group characteristics		Applied Fertilizer in 2010/2011		χ^2 P value
		Not Applied	**Applied**	
Group size	Small	10.0 (20.8)	38.0 (79.2)	0.552 NS
	Large	2.0 (16.7)	10.0 (83.3)	
Group education	Educated members	4.0 (15.4)	22.0 (84.6)	0.328 NS
	Uneducated members	8.0 (23.5)	26.0 (76.5)	
Age of group members (Individuals)	Young	7.0 (28.0)	18.0 (72.0)	0.163 NS
	Old	5.0 (14.3)	30.0(85.7)	
Venues for group meetings	Members' home	8.0 (33.3)	16.0 (66.7)	0.039*
	Public places	4.0 (11.1)	32.0 (88.9)	
Frequency of group meetings	Weekly	2.0 (12.5)	14.0 (87.5)	0.681 NS
	Fortnightly	3.0 (23.1)	10.0 (76.9)	
	Monthly	7.0 (22.6)	24.0(77.4)	
Prompt for group formation	external influences	5.0 (33.3)	10.0(66.7)	0.133 NS
	internal issues	7.0 (15.6)	38.0(84.4)	
Reason for applying inorganic fertilizer	Ease of application	2.0 (5.9)	32.0 (94.1)	0.043*
	Fast growth & maturity	2.0 (33.3)	4.0 (66.7)	
	High yields	5.0 (29.4)	12.0 (70.6)	
		Mean	**Mean**	**t-test**
Number of males in the group		9.3	6.6	0.470 NS
Number of females in the group		16.6	16.0	0.883 NS
Group age (Single entity)		6.0	7.2	0.442 NS
Tropical Livestock Unit (TLU)		1.5	2.0	0.025*

N=60, *association significant at $\alpha = 0.05$
Values in parenthesis are in percentages

The results showed that the ages of the groups (as entities) that applied fertilizer were almost equal, the sizes of the groups that applied fertilizer were almost equal, and the frequency of group meetings of the groups that applied fertilizer were almost the same. This implied that the number of years the group had operated (age) or the frequency of the group meetings did not influence the application of inorganic fertilizer. It also implied that both large and small groups were not different in their application of inorganic fertilizer (Table 4.5).

The results however showed that the reason for the preference for inorganic fertilizer is its ease of application (Table 4.5). This means that the man hours used in applying fertilizer are less as compared to manure or a combination of manure plus fertilizer. The frequency of using and the acceptance of a particular soil fertility improvement technology affect the adoption (Lawal *et al.,* 2014). If technologies are easy to use and have advantages over traditional practices, then scaling out is more likely to occur. Kabwe (2010) also found out that proximity to markets for inorganic fertilizers limit adoption of biomass transfer since farmers resort to easier and quicker means of soil fertility replenishment.

Group meeting venues significantly (p=0.039) influenced application of inorganic fertilizer (Table 4.5). A majority of the groups (88.9%) that applied fertilizer held their meetings in public places while 66.7% of the groups that applied fertilizers held their meetings at members' homes. Such public places include churches and schools where community members feel free to interact with each other irrespective of their backgrounds, status, religions and ages, and also irrespective of their differences at the village and family levels. This is in line with Gwandu *et al.* (2014), who found out that venues of farmer meetings such as farmer to farmer visit and farm visits had an influence on the dissemination of information on ISFM technologies. Davis (2004) also found out that 'barazas' and churches were the main venues for training and information dissemination. 'Barazas' are public gatherings, which are normally held in public places like chief's office compound, schools and churches. Churches and schools are institutions which are built to provide the community with amenities that serve their spiritual and academic development. These are public institutions are accessible (Mugwe *et al.*, 2009) and within proximity where community members meet and build relationships. Farmer groups that meet in them do not meet as strangers but usually share attachments from the many other meetings that take place there. Such groups are likely to be quite cohesive. On the other hand, these institutions normally have infrastructure which can comfortably be used by the groups as they hold their meetings.

The results of the Logit model are presented in (Table 4.6). The model was significant at $p<0.01$ and correctly predicted 86.8% of both that applied and those that did not apply inorganic fertilizer. Qualification of group membership ($p=0.028$), prompt of group formation ($p=0.098$) and the Tropical Livestock Unit (TLU) ($p=0.045$) were significant in explaining the application of inorganic fertilizer in Mbeere South and Maara sub-counties (Table 4.4).

Table 4.6: Group characteristics influencing application of inorganic fertilizer technology by groups in the Mbeere South and sub-counties

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
No of beneficiaries of agric activities in the group	0.134	0.109	1.507	0.220	1.144
Tropical Livestock Unit	1.926**	0.963	4.000	0.045	6.859
Group formation prompt	1.891*	1.143	2.736	0.098	6.624
Membership qualification	1.624**	0.741	4.802	0.028	5.073
Ages of group members	0.686	1.202	0.326	0.568	1.986
Educated group	0.222	0.231	0.925	0.336	1.248
No of females in the group	-0.336	0.275	1.499	0.221	0.714
No of males in the group	-0.395	0.281	1.979	0.160	0.674
Frequency of group meetings	0.250	0.658	0.144	0.704	1.284

N=60, **Significant at 5% probability level, *Significant at 10% probability level

The reason that prompted the group to start significantly (β= 1.891, *p*=0.098) influenced the application of inorganic fertilizer (Table 4.6). Results show that a majority (84.4%) of the groups that applied inorganic fertilizer were prompted to start by internal issues. These issues include inadequate financial resources, social support, agricultural marketing and risk coping strategies. Farmer groups are established for different reasons including: access to credit, technologies, poverty reduction, extension delivery and marketing (Salifu *et al.*, 2010). This means that if 'poor' farmers realized that they had soil fertility need, they would come together on top of joining many groups. Ondieki-Mwaura *et al.* (2013) noted that donors and NGOs prefer to use of farmer groups in the introduction of new technologies or as a contact point with the community. Therefore, farmer groups should be used as a form of social capital to enhance experience, training, marketing and access to markets (Korir *et al.*, 2015).

The Tropical Livestock Unit (TLU) significantly (β= 1.926, *p*=0.045) influenced the application of inorganic fertilizer (Table 4.6) which implies that an increase in the TLU increases the likelihood of farmers to make decision to apply inorganic fertilizer. Ownership of domestic animals is assumed to increase availability of manure and to generate income through sales of the animals or their products and is thus hypothesized to accelerate adoption of inorganic fertilizers (Odendo *et al.*, 2010; Kato *et al.*, 2011). Mugwe *et al.* (2009) also reported that birds (poultry) are not only seen as a source of wealth but also manure providers. Birds or manure sales could provide capital to invest in inorganic fertilizers.

4.2.3 Group characteristics influencing the application of animal manure + fertilizers in Mbeere South and Maara sub-counties

Results of univariate analysis showed that the reason for applying the combination (p=0.022) and the group age (p=0.008) was associated with the use of animal manure + inorganic fertilizer application (Table 4.7). However, group size and frequency of group meetings did not have a significant association with the application levels of animal manure plus fertilizer (Table 4.7).

Table 4.7: Group characteristics influencing application of a combination of manure + fertilizer technology by groups in the Mbeere South and Maara sub-counties

Group characteristics		**Applied Manure + fertilizer in 2010/2011** **Not Applied**	**Applied**	**χ^2 P value**
Group size	Small	10.0(20.8)	38.0 (79.2)	0.552 NS
	Large	2.0 (16.7)	10.0 (83.3)	
Group gender	Male	1.0 (33.3)	2.0 (66.7)	0.733 NS
	Female	4.0 (23.5)	13.0 (76.5)	
	Mixed	7.0 (17.5)	33.0 (82.5)	
Reason for applying combination	High yields	6.0 (14.3)	36.0 (85.7)	0.022*
	Soil fertility & structure	1.0 (16.7)	5.0 (83.3)	
	Fast growth & maturity	5.0 (55.6)	4.0 (44.4)	
Group education	Not educated	8.0 (30.8)	18.0 (69.2)	0.067*
	Educated	4.0 (11.8)	30.0 (88.2)	
Age of group members	Young	4.0 (16.0)	21.0 (84.0)	0.376 NS
	Old	8.0 (22.9)	27.0 (77.1)	
Frequency of group meeting	Weekly	2.0 (12.5)	14.0 (87.5)	0.469 NS
	Fortnightly	4.0 (30.8)	9.0 (69.2)	
	Monthly	6.0 (19.4)	25.0 (80.6)	
		Mean	**Mean**	**t-test**
Number of males in the group		5.1	7.7	0.480 NS
Number of females in the group		15.0	16.4	0.695 NS
Group age		10.1	6.1	0.008**
Tropical Livestock Unit (TLU)		2.0	1.9	0.775 NS

N=60, **association significant at $\alpha = 0.001$, *association significant at $\alpha = 0.05$

The reason for applying a combination of manure + fertilizer by the group significantly (p=0.022, $\chi^2 = 7.673$) influenced application of manure + fertilizer (Table

4.7). A majority (85.7 %) of the groups that applied a combination did so because of its association with high yields while 44.4% of groups that applied the combination did so because of its association with fast crop growth and maturity. This implies that an increase in the application of the combination is influenced by its association with high yields. This could be because most groups never felt that manure was unavailable, now that they just collect it from their cattle sheds, and combining it with fertilizer gave high yields. Combination of manure plus fertilizer has also been reported to give the highest yields. This agrees with Chapagain and Gurung (2013) who reported that high and sustained crop yield could be obtained with judicious and balanced NPK fertilization combined with organic matter amendments. The use of manure and fertilizer has increased steadily over the last few years, partly due to some users' strong belief in fertilizers despite challenges in the dissemination of ISFM technologies among farmers (Kilelu *et al.,* 2013). Studies have also shown that combining organic amendments and mineral fertilizers is often the best strategy for maintaining or even increasing soil fertility (Wopereis *et al*., 2009; Odendo *et al.*, 2010).

Group with educated members significantly (*p*=0.067) influenced application of manure + fertilizer (Table 4.7). In the study, groups that had over half of their members having attained secondary school education and above were considered educated and vice versa. Results therefore showed that educated groups applied more manure plus fertilizer as opposed to the less educated ones. This implies that an increase in the educated members in the group increases application of manure plus fertilizer. This is because education changes the farmers' attitudes and makes them open to changes and embrace new technologies. This suggests that farmers with some level of formal education are well aware of the soil degradation problem and the synergetic effects of using multiple sources of plant nutrients (Green, 2003). However, some in some instances education has been shown to have a negative effect on the adoption of soil conservation technologies (Alufah *et al.,* 2012). Manure application may not need education, but when it comes to the combination, education is crucial because of understanding the dynamics in fertilizer use, fertilizer nutrient combinations, nutrients deficiencies in the soils, rates of use, timings of the application, and finally the combination ratios of manure plus fertilizer. The awareness of farmers on different soil fertility technologies has an influence on the adoption of those technologies (Mustafa-Msukwa *et al.,* 2011; Rathgeber, 2011).

According to Chi (2008), farmers with high education had better recognition of advantages of new technologies and acquisition of the technical knowledge and information. However in some instances education does not significantly influence the use of fertilizer or the adoption of soil fertility technologies (Zhou *et al*., 2011; Murage *et al*., 2012). On the other hand, higher education broadens the opportunities of the farmers to engage in off-farms income generating activities which in turn can support investment in on-farm activities including SFE technologies for higher incomes. This agrees with Odendo *et al*. (2010) who found out that higher education level are most likely to obtain off-farm income through employment, hence hasten the adoption of the fertilizer used in the combination. Therefore, public interventions aimed at improving access to education through the use of farmers groups are likely to improve the likelihood of using ISFM practices among smallholder farmers in the study area (Magreta *et al.,* 2010).

The age of the groups negatively (p=0.008) influenced the application of a combination of manure plus fertilizer (Table 4.7). From the study, the age of the group implied the number of years a group had exited as an entity. The results showed that the groups with a mean age of 6.1 years applied combination more as compared to the groups with a mean age of 10.1 years. This implies that the younger the group, the more the likelihood of applying a combination of manure plus fertilizer. The reason could be that groups that had lasted few years had opportunities to interact with new ideas and technologies unlike the old groups. This could be because a lot of research has taken place in the region in the recent years and such groups could have had interactions with new people, ideas and technologies. Recent years have also seen a lot of social, political and governance changes in Kenya. The newer groups are therefore more dynamic in terms of leadership and with inquisitive attitudes and also open to trying new things. This agrees with Mwangi *et al.* (2011) who found that newly formed groups have more regular monitoring than the mature or older groups. He also noted more conflicts reported by newly formed groups as compared to old groups. Age has an influence on the adoption of soil and land management practices (Lawal *et al.,* 2014). The likelihood of joining a farmer group is influenced by age which may imply that some members may join a group out of peer influence (Davis *et al.,* 2010). This is true especially where the group have some basic literacy, business skills and experience, making the group members become the source of their capital and resources.

The results of the Logit model are presented in (Table 4.8). The model was significant at p<0.01 and correctly predicted 80.7% of both that applied and those that did not apply manure plus fertilizer. Number of females in the group (p=0.067), reason for applying combination (p=0.003) and group gender (p=0.056) were significant in explaining the application of inorganic fertilizer in Mbeere South and Maara sub-counties (Table 4.8).

Table 4.8: Group characteristics influencing application of a combination of manure + fertilizer technology by groups in the Mbeere South and Maara sub-counties

Independent variable	B	S.E.	Wald	Sig.	Exp(B)
Group age	-0.090	0.091	0.973	0.324	0.914
No of females in the group	-0.142**	0.078	3.349	0.067	0.867
Educated group	0.128	0.098	1.726	0.189	1.137
Age group members	0.683	0.949	0.517	0.472	1.980
Venue of group meeting	0.977	0.879	1.236	0.266	2.657
Tropical Livestock Unit	0.294	0.487	0.364	0.546	1.342
Reason for combination	-1.848*	0.623	8.793	0.003	0.158
Group gender	1.577**	0.825	3.655	0.056	4.839

N=60, **Significant at 5% probability level, *Significant at 10% probability level

The number of females in the groups negatively (β= -0.142, p=0.067) influenced the application of combination of manure plus fertilizer (Table 4.8). That means that an increase in the number of females in a group decreases the group's application of the combination of manure plus fertilizer. This is especially in mixed gendered groups. Normally, women have been treated as physically weaker sex and when they are in mixed groups, they could take advantage of that and leave most of the application work to the men in the group. This agrees with Mwangi *et al.* (2011) who found that higher proportions of females in user groups, and especially user groups dominated by females perform less well than mixed groups or male dominated ones. Simply adding women to groups does not lead to greater effectiveness. Women's inclusion in collective action needs to be accompanied by measures to strengthen their capacities for assuming active roles, including leadership positions (Quisumbing and Pandolfell, 2008).

Group gender influenced (β= 1.577, *p*=0.056) the application of a combination of manure plus fertilizer (Table 4.8). Results showed that 82.5% of the groups that applied a combination were mixed gendered (N=40), while 66.0% of the groups that applied a combination were male gendered (N=3). This implies that when men and women are mixed, there is synergy from both gender and the results are better. When the two genders are in the same group, it shows that they have accepted each other with their different contributions. The participation in farmer groups is affected by the gender of the head of the group (Milla *et al.,* 2014). According to Sanginga (2005) men are perceived as more able to make decisions, organize group activities and maintain discipline in groups. They are also better placed to establish contacts with external institutions and to voice their needs and demands. Therefore, since there are inherent male biases, the likelihood of male joining groups that are male headed are reduced (Rathgeber, 2011). There is a difference in the adoption rates of agriculture technologies between genders and the ease of use of certain technologies such as farm machines (Carr, 2010). Kaaria and Ashby (2005) reported that the higher participation of women can be explained by their dormant roles and responsibilities in crop production. However, the gender of an individual may have a negative effect on the adoption of soil fertility technologies (Barungi *et al.,* 2013).

4.3 The influence of trainings on farmers' decision to select soil fertility enhancement technologies in Mbeere South and Maara sub-counties in 2010/2011

4.3.1 Selection of soil fertility enhancement technologies in relation to farmers' trainings in 2010/2011

Most (93.6%) of the farmers underwent trainings in the year 2010/2011 (Table 4.9). Among the trainings carried out, 98.2% of the farmers received soil fertility related trainings, (24.3%) underwent group dynamic related trainings, 39.4% underwent production related training and 19.7% got marketing related trainings (Table 4.9).

Table 4.9: Trainings in the Mbeere South and Maara sub-counties the year 2010/2011

Farmers trained in 2010/2011		**Frequency**	**Percent**
Farmers who underwent trainings in 2010/2011	No	14.0	6.4
	Yes	204.0	93.6
Farmers who trained in soil fertility in 2010/2011	No	4.0	1.8
	Yes	214.0	98.2
Farmers who trained in group dynamics in 2010/2011	No	165.0	75.7
	Yes	53.0	24.3
Farmers who trained in production in 2010/2011	No	132.0	60.6
	Yes	86.0	39.4
Farmers who trained in marketing in 2010/2011	No	175.0	80.3
	Yes	43.0	19.7

N=218

This implies that a majority (93.6%) of farmers who received training got soil fertility trainings (98.2%). This means that soil fertility was an issue that farmers needed addressed since they could come out in large numbers when offered these trainings. It could also be that soil fertility issues were fundamental in supporting livelihoods in terms of production and marketing. This agrees that with Wopereis *et al.* (2009) who found out that soil fertility management is crucial for maintaining or increasing the yields and incomes of the majority of farmers in Sub-Saharan Africa. This could also be that the mobilization methods used to call farmers for the soil fertility trainings were smart. The methods used in training of farmers such as field days, farmer field schools and farmer teachers have an impact on the adoption of soil fertility technologies (Murage *et al.,* 2012). The awareness of farmers on the soil fertility problems and the options to improve the conditions affects the interest of farmers in soil fertility management (Gebre and Weldemariam, 2013).

4.3.2 Use of animal manure

There was no significant relationship between selection of animal manure and farmers' trainings (χ^2=0.127, p=0.466) (Table 4.10). Majority (54.9%) of the respondents who selected manure had undergone training in 2010/2011, while 50% who selected manure had not been trained in 2010/2011. A majority (50%) of the respondents who had not selected animal manure had not been trained the previous year, while 45.9% of the respondents who had not selected animal manure had been trained the previous year (Table 4.10).

This implies that almost an equal number of farmers that selected and those that did not select manure were both trained in 2010/11 (Table 4.10). This means that as far as manure selection is concerned, the trainings did not have an influence. This could be because manure technology has been used since time in memorial and its use might not have needed much training. Farming experience and knowledge have a positive effect on the adoption of manure (Odendo *et al.*, 2010; Mustafa-Msukwa *et al.*, 2011).

4.3.3 Use of inorganic fertilizer

There was no significant relationship between selection of inorganic fertilizer and farmers' trainings (χ^2=1.940, p=0.132). Majority (78.6%) of the respondents who never selected inorganic fertilizer had not undergone training in 2010/2011, while 59.8% of the respondents who never selected inorganic fertilizer had been trained during the same period. A majority (40.2%) of the respondents who had selected inorganic fertilizer had been trained in 2010/2011, while 21.4% of the respondents who had selected fertilizer had not been trained during the same period (Table 4.10).

This implies that almost an equal number of farmers that used and those that did not use fertilizer were both trained in 2010/11 (Table 4.10). This means that as far as fertilizer use is concerned, the trainings did not have an influence. The farmer perceptions and training have been shown to have an influence on the adoption of soil fertility technologies (Alufah *et al.,* 2013). The low use of soil fertility technologies may also have been the difference in the rate of adoption and opinions among the group members (Magreta *et al.,* 2010). There was also a possibility that there were constrained by the high cost of fertilizers, the low purchasing power of smallholders and the restricted access to credit (Lawal *et al*., 2014).

4.3.4 Use of manure + inorganic fertilizer

There was a significant relationship between selection of manure + inorganic fertilizer and farmers' trainings (χ^2=3.865, *p*=0.043). Majority (51.5%) of the respondents who selected manure + fertilizer had undergone training the previous year, while 21.4% of the respondents who never selected manure + fertilizer had not been trained the previous year (Table 4.10).

Table 4.10: Farmers' trainings and the selection of manure, fertilizer and manure + fertilizer in the Mbeere and Maara sub-counties in 2010/2011

		Used SFE Technologies in 2010/2011					
		Manure		Fertilizer		Combination	
		No	Yes	No	Yes	No	Yes
Farmers trained in 2010/2011	No	70.0 (50.0)	70.0 (50.0)	11.0 (78.6)	3.0 (21.4)	3.0 (21.4)	11.0 (78.6)
	Yes	92.0 (45.1)	112.0 (54.9)	122.0 (59.8)	82.0 (40.2)	99.0 (48.5)	105.0 (51.5)
	χ^2	0.127		1.940		3.865	
	P value	0.466		0.132		0.043	

Values in parentheses are in percentages

The results showed that training had no influence on use of manure and fertilizer but had influence on combination (Table 4.10). There was a significant (*p*=0.043) association between the farmers' training and the application of a combination of manure + fertilizer. This implies that an increase in farmers' trainings increases their chances of selecting manure + fertilizer. The reason could be because unlike manure and fertilizer use, understanding the dynamics of the combination in the soil may require more contacts with the trainer. Sanginga and Woomer (2009) and Alufah *et al.* (2012) noted that training significantly influenced access to ISFM information and knowledge and its subsequent adoption, such that the more the trainings, the more the knowledge acquired about manure plus fertilizer use. This agrees with Gwandu *et al.* (2014) that with better knowledge, at least of basic principles of good soil fertility management, farmers could do much to improve farm productivity. Mutuma (2013) also found out that persons in close contact with development organizations increase their knowledge of soil fertility management. Similarly, Murage *et al.* (2012) noted that training addresses the challenges on lack of knowledge by creating awareness.

4.4 Socio-economic characteristics of the households influencing decision to select soil fertility enhancement technologies

4.4.1 Socio-economic factors influencing the farmers' selection of animal manure

Results of univariate analysis of socio-economic factors influencing farmers' selection of animal manure showed that seven variables were significant in explaining farmers' selection of animal manure. These variables are benefits of animal manure, source of knowledge of manure, most effective method of teaching manure, size of the household, Household's total land size, household's land under food crops and Tropical Livestock Units (TLU) (Table 4.11). However, age of household head, HHH education and household head gender did not have a significant association with the selection of animal manure (Table 4.11).

Table 4.11: Socio-economic factors influencing farmers' selection of animal manure in Mbeere South and Maara sub-counties

Characteristic		**Used animal manure in 2010/2011**		χ^2 **P value**
		No	Yes	
HHH gender	Male	53 (41.4)	75.0 (58.6)	0.101 Ns
	Female	46.0 (51.1)	44.0 (48.9)	
Educated	Not educated	51.0 (41.5)	72.0 (58.5)	0.116 NS
	Educated	48.0 (50.5)	47.0 (49.5)	
Benefits of animal manure	Fertile soil	42.0 (51.2)	40.0 (48.8)	0.011*
	High yields	27.0 (29.0)	66.0 (71.0)	
	Water retention	8.0 (38.1)	13 (61.9)	
Source of knowledge of manure	Extension	29.0 (48.3)	31.0 (51.7)	0.023*
	Researchers	58.0 (40.0)	87.0 (60.0)	
	Other farmers	7.0 (87.5)	1.0 (12.5)	
Most effective method to teach manure	Demonstrations	51.0 (37.2)	86.0 (62.8)	0.024*
	Meetings	20.0 (57.1)	15.0 (42.9)	
	Media	23.0 (56.1)	18.0 (43.9)	
Participation in group activities	No	4 (44.4)	5 (55.6)	0.998 Ns
		Mean	**Mean**	**t- test**
HH size		4.5	5.5	0.001*
HH total land		3.0	5.2	0.001*
HH land under food crops		1.5	2.6	0.001*
Tropical Livestock Unit (TLU)		1.8	3.1	0.001*
HHH age		49.5	51.0	0.389 NS

N=218, * association significant at $\alpha = 0.05$

The results indicate that manure selection was not affected by the farmers' gender, such that the males that selected manure were almost equal to the females that selected manure. Selection of manure was also not dependent on the farmers' age since the number that selected manure was almost the same across all ages. This means that both males and female household heads selected manure almost equally. It also means that both the young and the elderly household heads selected manure almost equally.

The benefits derived from manure significantly (P=0.011, χ^2=9.008) influenced the selection of manure (Table 4.11). The results showed that a majority (71.0%) of the farmers that selected manure did so because of its benefit of high yields, while 48.8% selected it because of its benefit of fertile soil. This implies that an increase in the yields as a benefit increases the probability of the farmers' selection of manure. This agrees with Barungi *et al.* (2013) showed that farmers perception that soils were moderately fertile negatively influence the adoption of soil fertility technologies.

The source of knowledge of manure significantly (P=0.023, χ^2=7.536) influenced the selection of manure (Table 4.11). Results showed that a majority (60.0%) of farmers that selected manure received manure knowledge from researchers, while 12.5% of them that selected manure got their manure knowledge from other farmers. Researchers are able to investigate the dynamics of soil fertility, develop the appropriate technologies and pass the information to the extension agents and other players including the final consumers, who are the farmers. This agrees with Gwandu *et al.* (2014) who reported that farmers that are involved in on-farm experimentation and had interaction with extension agents and researchers are more likely to adopt soil fertility management technologies than those who are not. During farmers' trainings, researchers try to use approaches that are designed to improve the flow of information between farmers and researchers about technology performance and appropriateness under farmer conditions (Mugwe *et al.*, 2009; Mustafa-Msukwa *et al.*, 2011). Mutuma (2013) also found out that persons in close contact with development organizations increase their knowledge of soil fertility management.

The most effective method to teach manure significantly (P=0.024, χ^2=7.434) influenced the selection of manure (Table 4.11). Results showed that a majority (62.8%) of farmers that selected manure were taught about it through demonstrations (Field-days, mother-baby, demonstrations, show/exhibitions, groups), while 42.9% of them that selected manure was taught about it through meetings (Barazas, seminars and workshops). This implies that farmers' learning is enhanced if they are exposed to the technologies through demonstrations. Demonstration methods create forums where farmers physically interact with technologies, make enquiries about them, and also share experiences on their use. Mustafa-Msukwa *et al.* (2011) reported that farmer training received by farmers influenced the adoption of manure for use in their farms. This agrees with findings by Wollni and Anderson (2013) who reported that demonstration methods are actually participatory methods that are part of a paradigm that offers ample space for the potential benefits of unsupervised learning. These also agree with the findings that field days are organized sessions where farmers meet resource persons, be they extensionists or researchers, to discuss important topics (Wollni and Anderson, 2013). They often involve both discussions and demonstrations on a set of technologies (Murage *et al.*, 2012). Belay and Abebaw (2004) pointed out that extension teaching methods such as field demonstrations, field days and farm visits are expected to enhance adoption of new technologies through creation of awareness, exchange of ideas and skill acquisition. Eneku *et al.* (2013) also concurs that field days is one of the approaches aimed to support local innovation and adaptation and joint learning of scientific principles.

There was a significant (P=0.001) relationship between the HH total land and the selection of animal manure (Table 4.11). Results showed that the farmers who had a mean of 5.2 acres selected manure as compared to those who had a mean of 3.0 acres who did not select manure. This implies that an increase in the land increases the likelihood to select manure. This could be because owning big land could mean availability of resources in terms of land, domestic animals or even capital, which could facilitate manure availability and also labour for incorporation. This agrees with Ngwira *et al.* (2014) who found out that larger farm size is associated with greater wealth, increased availability of capital, and high risk bearing ability which makes investment in conservation more feasible. Moreover, farmers operating larger farms can afford to devote part of their fields sometimes the less productive parts to try out the improved technology, and this may influence adoption (Odendo *et al.*, 2010). It is hypothesized that large farm size increases the probability of the adoption of all the studied practices. However some studies have shown that land size may have a negative effect on the adoption of soil fertility improvement technologies (Alufah *et al.*, 2012; Zhou *et al.*, 2011).

The results of the Logit model developed to determine factors influencing use of animal manure was significant at $p<0.01$ and correctly predicted 67.4% of both users and non users of animal manure with the selection and non selection of animal manure (Table 4.12). Size of the household ($p=0.096$), farmer's education ($p=0.075$), land with or without title deed ($p=0.056$), land under food crops ($p=0.014$), Tropical Livestock Units on the farm ($p=0.036$) and benefits of animal manures ($p=0.062$) were significant in explaining the selection of animal manure in Mbeere South and Maara sub-counties (Table 4.12).

Table 4.12: Logistic regression estimates of factors influencing selection of animal manure technology in the Mbeere South and Maara sub counties

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
HH marital status	0.829	0.845	0.964	0.326	2.291
Education	-0.564*	0.316	3.179	0.075	0.569
HH size	0.147*	0.088	2.779	0.096	1.158
Land under food crops	0.397**	0.161	6.081	0.014	1.487
Land with/without title	-0.655*	0.342	3.659	0.056	0.520
TLU	0.206**	0.099	4.376	0.036	1.229
Animal manure benefits	0.163*	0.087	3.482	0.062	1.177

N=218, **Significant at 5% probability level, *Significant at 10% probability level

Household head education negatively influenced (β= -0.564, p=0.075) the selection of animal manure (Table 4.12). This implies that an increase in the household head education did not necessarily increase the chances of selection of animal manure. That means that lack of formal education did not hinder the households from selection of manure. This could be because manual application of manure may just require observation as a demonstrator illustrates the amount to apply, how to apply and the equipment to use. This also means that an increase in education could mean more opportunities to earn off-farm income which could be a dis-incentive in investing in manure. Off-farm income negatively influenced farmer uptake of ISFM as sometimes individuals with higher incomes tend to invest their time, energies and money in non-farm activities at the expense of on-farm activities (Adolwa *et al.*, 2010). These results agree with those of Odendo *et al.* (2010) that education was not found to play a major role in the decision to take up technologies. Preparation and application of manure may require practical hands-on management, skills and conceptual understanding based on non-formal adult education principles (Alufah *et al.*, 2012). The study by Nata *et al.* (2014) showed that the education level did not have any significant effect on the household adoption of soil improving practices in Ghana. However, Gebre and Weldemariam (2013) found that there was no relationship between education level and farmers' perception and participation in mechanical soil and water conservation techniques in Ethiopia. This is contrary to Adong *et al.* (2012) that found, a positive relationship between the education level and participation in farmer group activities.

Household size positively influenced (β=0.147, *p*=0.096) the selection of manure (Table 4.12). This implies that an increase in the household size increases the selection of manure. This could be because a higher number of household members can provide timely labour that is required to apply manure since manure application is a labour intensive activity. Household labour provision is very important for speeding up implementation of labour intensive technologies such as manure application. This is consistent with Odendo *et al.* (2010) who found out that due to high labour demands for preparation and application of manure, compost and mineral nutrient sources, higher ratio of household members who contribute to farm work is hypothesized to increase the speed of the adoption of all the studied practices because of the low opportunity cost of labour in Western Kenya. Kato *et al.* (2011) also reported that labour constraints had a significant impact on the adoption decision and dissemination of ISFM technologies,, as they are a relatively labour-intensive activity. The ratio of household members who provide farm labour to total household size accelerated the adoption of manure as expected (Odendo *et al.*, 2010). At the same time, the household size also can address issues of synergy in SFE technology adoption. This agrees with Lawal *et al.* (2014) who found out that the higher number of family members leads to higher decision to take risks for participation in technology packages and this leads to increased chances of getting agricultural information and consequently ISFM knowledge. Family can be a source of information and will therefore have an influence on the decision making process. The household size influences adoption of soil fertility technologies through increase in knowledge base (Alufah *et al.,* 2012; Murage *et al.*, 2012). Similarly, households with large numbers have more labour and needed more food, both of which increased the tendency to learn more on how to conserve the soil in order to feed themselves (Odendo *et al.,* 2010).

Total land under food crops significantly (β= 0.397, p=0.014) influenced the selection of manure (Table 4.12). This implies that an increase in the land under food crops increases the selection of manure. The land sizes can favour the adoption of new technologies and offer trials areas. These results contradict those of Alufah *et al.* (2012) that showed a negative relationship between the land size and the adoption of soil and water conservation practices. The negative relationship may have been due to the scarcity of land and therefore the available land was used judiciously. In addition to providing food security, food crops can also be sources of farm income. Barhama and Chitemi (2008) reported that cereals and legumes are the traditional staple food crops for many smallholders, and that when these staple food crops are grown on a large scale, they offer substantial regional and international market potential. Such food crops can therefore attract attention and enhance the likelihood of selection of inorganic fertilizer and other soil fertility enhancing technologies.

Owning land with title deed negatively influenced (β= -0.655, p=0.056) the selection of manure (Table 4.12). This implied that owning land with title did not necessarily increase the likelihood of selecting manure. This could be because the land with title could be far and with poor communication, or that the crop grown did not attract good market, and therefore not profitable enough to warrant investing in manure. Kato *et al.* (2011) identified land tenure as one of the factors that had an influence on up scaling of the soil fertility technologies. Rathgeber (2011) noted that the land ownership status affected the decision by women to invest in soil fertility technologies.

Tropical Livestock Units (TLU) a farmer owns significantly ($\beta = 0.206$, $p = 0.036$) influenced the selection of manure (Table 4.12) which implies that an increase in the number of domestic animals increases the likelihood of farmers to make decision to select manure. Ownership of domestic animals is assumed to increase availability of manure and to generate income through sales of the animals or their products and is thus hypothesized to accelerate adoption of manure and mineral fertilizers (Odendo *et al.*, 2010). The ownership of livestock has been shown to have a direct effect on the participation of farmer group activities such as adoption of ISFM technologies (Milla *et al.*, 2014).

4.4.2: Socio-economic factors influencing the farmers' selection of inorganic fertilizer

Results of univariate analysis of socio-economic factors influencing farmers' selection of inorganic fertilizer showed that four variables were significant in explaining farmers' selection of inorganic fertilizer. These variables are: education, whether the household head was either full time or part-time farmer, availability of farm income and total land under food crops (Table 4.13). However, age of household head, household head gender, and number of months spent on the farm did not have a significant association with the selection of animal manure (Table 4.13).

Table 4.13: Univariate results of socio-economic factors influencing farmers' selection of inorganic fertilizer

Characteristic		**Used mineral fertilizer in the year 2010/2011**		χ^2 **P value**
		No	**Yes**	
HHH gender	Male	81.0(63.3)	47.0(36.7)	Ns
	Female	52.0(57.8)	38.0(42.2)	
Education	Not educated	68.0 (55.3)	55.0 (44.7)	0.033*
	Educated	65.0 (68.4)	30.0 (31.6)	
Fulltime or part-time farmer	Part-time	14.0 (45.2)	17.0 (54.8)	0.041*
Any on-farm income	No	9.0 (37.5)	15.0 (62.5)	0.012*
	Yes	124.0 (63.9)	70.0 (36.1)	
Benefits of inorganic fertilizer	Fertile soil	9.0 (75.0)	3.0 (25.0)	0.064
	High yields	59.0 (56.7)	45.0 (43.3)	
	Early maturity	28.0 (43.1)	37.0 (56.9)	
Source of knowledge for fertilizer	Extension	34.0 (64.2)	19.0 (35.8)	0.233
	Researchers	89.0 (60.5)	58.0 (39.5)	
	Other farmers	5.0 (38.5)	8.0 (61.5)	
Most effective method to teach fertilizer	Demonstrations	43.0 (59.7)	29.0 (40.3)	0.988
	Meetings	40.0 (59.7)	27.0 (40.3)	
	Media	45.0 (60.8)	29.0 (39.2)	
		Mean	**Mean**	**t- test**
No of months on the farm		8.3	9.0	Ns
HH land under food crops		1.8	2.5	0.012*
HHH age		49.8	51.2	0.406 NS
Tropical Livestock Unit (TLU)		2.4	2.5	0.804 NS

N=218, * association significant at $\alpha = 0.05$

Availability of farm income negatively (P=0.012, χ^2=6.266) influenced the selection of fertilizer (Table 4.13). Results showed that a majority (68.4%) of the farmers that had on-farm income did not select fertilizer, while 31.6% of the farmers that had on-farm income selected fertilizer. This implies that an increase in the availability of on-farm income does not necessarily increase the probability of fertilizer selection. This could be because the farmers might have preferred to invest in other technology options but not fertilizer. Other times, farmers do not adopt because the technology does not fit with their existing options. Giller *et al.* (2009) in his study reported that farmers' involvement in new technologies requires tradeoffs with other activities from which they currently generate their livelihood and if the new technology does not fit with them, they will hesitate to take it up. Cash income has a positive effect on the use of mineral fertilizers due to the affordability (Odendo *et al.,* 2012). However, off farm income has been shown to have no significant effect on the farmer decision to use fertilizer in China (Zhou *et al.,* 2011).

The results of the Logit model developed to determine factors influencing use of inorganic fertilizer was significant at $p<0.01$ and correctly predicted 70.2% of both users and non-users of inorganic fertilizers with the selection and non-selection of inorganic fertilizer (Table 4.14). Four variables: household head education (p=0.014), total land under food crops (p=0.031), availability of on-farm income (p=0.055) and whether the household head is a full-time or part-time farmer (p=0.019) were significant in explaining the selection of inorganic fertilizers in the central highlands of Kenya (Table 4.14).

Table 4.14: Factors influencing selection of inorganic fertilizer technology in the Mbeere South and Maara sub-counties

Independent variable	B	S.E.	Wald	Sig.	Exp(B)
HHH gender	-0.105	0.353	0.088	0.766	0.900
HHH Education	-1.070**	0.369	8.382	0.004	0.343
Number of groups one belongs to	0.094	0.220	0.183	0.669	1.099
Land under food crops	0.353**	0.164	4.661	0.031	1.424
Land with / without title deed	0.126	0.366	0.119	0.730	1.134
Tropical Livestock Unit (TLU)	-0.060	0.105	0.332	0.564	0.941
Any on-farm income	-1.342*	0.701	3.668	0.055	0.261
Benefits of fertilizer	0.399	0.310	1.661	0.197	1.490
Full time / part-time farmer	-1.194**	0.510	5.487	0.019	0.303

N=218, **Significant at 5% probability level, *Significant at 10% probability level

Household head education negatively (β=-1.070, p=0.004) influenced selection of inorganic fertilizer respectively (Table 4.14) which implies that inorganic fertilizer selection decreases with increase in education. This could be because as the education level increases there are other income options available other than farming. Alternatively the education received may have in other areas that were not related to agriculture. These results agree with Odendo *et al.* (2010) who reported that education had a negative influence on the adoption of mineral fertilizers in Western Kenya. The preparation and application of fertilizer may require practical hands-on management, skills and conceptual understanding based on non-formal adult education principles. These results disagree with the normal expectation that the education level of the household head to be positively related to productivity. Murage *et al.* (2012) had also found out that more educated household heads are more likely to have adopted Push and Pull technologies in Western Kenya than non-educated household heads. These results could therefore be because as long as fertilizer is available, application of it just needs to be demonstrated by an expert and this physical activity can be done even without formal education. Its rates of application can be determined by physical objects such as soda bottle tops. This calls for simplification of technical information by development professionals in order to help support farmers' understanding and communication of complex principles (Larsen and Lilleor, 2014). This also agrees with the results of Gebre and Weldemariam (2013) who noted that education was not found to play a major role in the decision of farmers to take up technologies.

Land under food crops positively influenced (β=0.353, p=0.031) the selection of inorganic fertilizer (Table 4.14). This implies that an increase in the size of the land under food crops increases the selection of inorganic fertilizer. In addition to providing food security, food crops can also be sources of farm income. The land size influences the decision to adopt new technologies (Mutuma, 2013). The presence of food crops can attract attention and enhance the likelihood of selection of inorganic fertilizer and other soil fertility enhancing technologies. Arifalo and Mafimisebi (2011) also found out that the respondents who applied inorganic fertilizers only, had the greatest yield of maize and yam crops.

Being a fulltime farmer negatively influenced (β=-1.194, p=0.019) the selection of inorganic fertilizer (Table 4.14). This implies that farmers who spent more time on the farm selected less of inorganic fertilizer. Lack of cash to buy fertilizer could have been the reason of non selection of fertilizer. Ajayi *et al.* (2007) noted that lack of cash to buy mineral fertilizers or non-availability of fertilizer in rural areas at the right time was a constraint in fertilizer adoption. This could also be because they had an opportunity to use other SFE technologies like manure which on the other hand required more time to prepare and apply and at the same time was cheaper than inorganic fertilizer. A fulltime farmer spends more time on the farm and therefore gets more experience on farm activities, including use of new technologies. A greater number of hours worked by the farmer lower the probability of adoption of new technologies (Dorfman, 1996). Odendo *et al.* (2010) found out that relative farming experience retards the adoption new technologies. Edemeades *et al.* (2008) however reported that relative farming experience increased the likelihood of the adoption of different banana varieties in Uganda.

4.4.3: Socio-economic factors influencing the farmers' selection of a combination of animal manure + fertilizer

Results of univariate analysis of socio-economic factors influencing farmers' selection of a combination of animal manure + inorganic fertilizer showed that six variables were significant in explaining farmers' selection of a combination of animal manure + inorganic fertilizer. These variables are household head education, availability of farm income, source of knowledge of a combination of animal manure + inorganic fertilizer, benefits associated with a combination of animal manure + inorganic fertilizer, most effective method used to train on the combination of animal manure + fertilizer and total land under food crops (Table 4.15). However, age of household head and household head gender did not have a significant association with the selection of animal manure (Table 4.15).

Table 4.15: Socio-economic factors influencing farmers' selection of a combination of animal manure + inorganic fertilizer

Characteristic		**Used Manure + Fertilizer in the year 2010/2011**		χ^2
		No	**Yes**	**P value**
HHH gender	Male	58.0 (45.3)	70.0 (54.7)	Ns
	Female	44.0 (48.9)	46.0 (51.1)	
Education	Not educated	72.0 (58.5)	51.0 (41.5)	0.001*
	Educated	30.0 (31.6)	65.0 (68.4)	
Any on-farm income	No	17.0 (70.8)	7.0 (29.2)	0.011*
	Yes	85.0 (43.8)	109.0 (56.2)	
Benefits of combination	Fertile soil	12.0 (46.2)	14.0 (53.8)	0.046*
	High yields	29.0 (24.4)	90.0 (75.6)	
	Early maturity	6.0 (42.9)	8.0 (57.1)	
Source of knowledge for combination	Extension	15.0 (55.6)	12.0 (44.4)	0.040*
	Researchers	76.0 (42.7)	102.0 (57.3)	
	Other farmers	8.0 (80.8)	2.0 (20.0)	
Most effective method to teach combination	Demonstrations	22.0 (21.6)	80.0 (78.4)	0.001*
	Meetings	37.0 (72.5)	14.0 (27.5)	
	Media	40.0 (64.5)	22.0 (35.5)	
		Mean	**Mean**	**t- test**
Land under food crops		2.4	1.8	0.041*
HHH age		51.3	49.4	0.277
Tropical Livestock Unit (TLU)		2.4	2.5	0.668

N=218, * association significant at $\alpha = 0.05$

Availability of farm income significantly (χ^2=6.262, P=0.011) influenced the selection of combination (Table 4.15). Results showed that a majority (56.2%) of the farmers that selected a combination had an on-farm income, while 29.2% of them that selected combination did not have on-farm income. This implies that an increase in the on-farm income increases the probability of farmers' selection of the combination. This could be that with the perception that a combination gives high yield, it would be logical for farmers to reinvest their on-farm income back into the farm in order to recoup more. The off farm income may increase the rate of adoption or use of a new technology after overcoming the financial constraint to up scaling (Odendo *et al.*, 2010). The increase in the use of the technology leads to an increase in the higher crop yield and vigour due to up scaling (Chapagain and Gurung, 2013). Because of higher yields and incomes, the rates of fertilizers, organics and irrigation have increased dramatically in intensive agricultural systems such as green houses (Mahmoud *et al.*, 2009).

The benefits associated with the combination significantly (χ^2=6.167, P=0.046) influenced the selection of a combination (Table 4.15). Results showed that a majority (75.6%) of the farmers that selected the combination did so because of its associated benefit of high yields, while 53.8% of them that selected a combination did so because of its associated benefit of fertile soil. This implies that when high yields are considered as a benefit, it increases the chances of farmers' selection of combination. This could be because a combination of manure plus fertilizer is not only perceived to give fertile soil, vigorous crops, moisture retention but also the highest yields. This agrees with Chapagain and Gurung (2013) who reported that high and sustained crop yield could be obtained with judicious and balanced NPK fertilization combined with organic matter amendments. Agegnehu (2014) noted that the use of manure and fertilizer has increased steadily over the last few years, partly due to some users' strong belief in fertilizers. Studies have also shown that combining organic amendments and mineral fertilizers is often the best strategy for maintaining or even increasing soil fertility (Vanlauwe *et al.,* 2010).

The source of knowledge of a combination significantly (χ^2=6.427, P=0.040) influenced the selection of combination (Table 4.15). Results showed that a majority (57.3%) of the farmers that selected combination got the knowledge from researchers, while 20.0% of them that selected combination got the knowledge about combination from other farmers. This implies that acquisition of knowledge from the researchers increases the selection of combination. This could be because researchers are not only able to investigate but also understand the soil fertility dynamics. When they communicate these issues with the farmers, they help the farmers to conceptualize the soil fertility dynamics.

This agrees with Gwandu *et al.* (2014) who reported that farmers go through a joint learning process with researchers and government extensionists because most agroforestry technologies such as improved fallows and biomass transfer are knowledge intensive technologies that require much understanding of the principles behind the practices before implementation. Researchers have been providing extension services to the farming communities especially in areas where extension at local community level was either not available or where they were challenged with resources (Murage *et al*., 2012). However, researchers need to devise means to ensure capacity building among extension workers alongside that of farmers, since they themselves cannot reach as many farmers as would extension workers through this approach (Salifu *et al.,* 2010).

The most effective method of teaching combination significantly (χ^2=47.532, P=0.001) influenced the selection of a combination (Table 4.15). Results showed that a majority (78.4%) of the farmers that selected combination were taught through demonstrations, while 27.5% of them that selected combination were taught through meetings. This implies that use of demonstrations as a teaching method increases the probability of farmers to select combination. Demonstration methods are participatory, involving logical description and explanation through experiments and at the same time, the farmers' involvement is high. According to Ondieki-Mwaura *et al.* (2013), the use of group approach in technology uptake and transfer has emerged as an important strategy of extending or introducing new technologies in developing countries. Murage *et al.* (2012) attested to this by reporting that a larger number of farmers should be involved in technology testing and field days should be held to disseminate the technology. Despite the constraints that are faced by farmers the use of group approaches, remains a viable option for farmers to access services (Kato *et al.,* 2011; Lawal *et al.,* 2014).

The results of the Logit model developed to determine factors influencing use of a combination of animal manure + inorganic fertilizer was significant at p<0.01 and correctly predicted 75.3% of both users and non users of the combination of animal manure + inorganic fertilizers with the selection and non selection of the combination (Table 4.16). Household head education (p=0.021), total land under food crops (p=0.058), Tropical Livestock Units (TLU) (p=0.011) and the most effective method to teach combination (p=0.001) were significant in explaining the selection of a combination of animal manure + inorganic fertilizers in the central highlands of Kenya (Table 4.16).

Table 4.16: Factors influencing selection of a combination of animal manure + inorganic fertilizers technology in the Mbeere South and Maara sub-counties

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
Education	1.004**	0.436	5.301	0.021	2.730
Land under food crops	-0.604*	0.318	3.601	0.058	0.546
Land with title deed	0.608	0.454	1.796	0.180	1.836
Tropical Livestock Units	0.441**	0.173	6.538	0.011	1.555
Participate in group activities	1.230	0.830	2.195	0.138	3.422
HH total land	0.258	0.157	2.694	0.101	1.295
Benefits of combination	0.138	0.399	0.120	0.729	1.148
Source of knowledge-combination	0.510	0.463	1.214	0.271	1.665
Effective method teach combination	-0.957**	0.265	13.021	0.001	0.384

N=218, **Significant at 5% probability level, *Significant at 10% probability level

Household head education significantly (β= 1.004, *p*=0.021) influenced the selection of manure plus fertilizer (Table 4.16). This implies that the more educated the farmers, the more likely they are to select manure + fertilizer technology. This is because education exposes the farmers to details of the manure + fertilizer use such as types, application rates, methods and timings, which are critical in productivity. The education of the head of the household positively and significantly influenced both the likelihood of adoption and intensity of inorganic fertilizer use (Davis *et al.,* 2010). Conventional methods are complex and difficult to use, particularly for non or semi-literate farmers with little or no formal education (Gwadu *et al*., 2014). Higher education also broadens the opportunities of the farmers to engage in off-farms income generating activities which in turn can support investment in on-farm activities including SFE technologies for higher incomes. This agrees with Odendo *et al*. (2010) who found out that higher education level are most likely to obtain off-farm income through employment, hence hasten the adoption. Higher education also provides a well founded knowledge base which may shape the farmer perception and awareness (Barungi *et al.,* 2013). The awareness will in turn determine the adoption and this also helps to support well informed decision making with respect to resource use and management (Gwandu *et al.*, 2014).

Land under food crops negatively influenced (β= -0.604, p=0.058) the selection of a combination of manure plus fertilizer (Table 4.16). This implies that an increase in the size of the land under food crops decreases the selection of a combination of manure plus fertilizer. This could be because of the labour involved since the use of combination requires a lot of labour for both preparation and application. Women provide a significant share of labour for farm activities and are important as primary producers of food crops (Carr, 2010; FAO, 2010). Women comprise of a majority of the members of CIGs that are food crops and small livestock production based (Hill, 2011). In most cases, high costs prohibit farmers from applying both manure plus fertilizer although they know that the resulting yields are high (Kato *et al*., 2011).

Total livestock unit (TLU) owned by the household significantly (β= 0.441, p=0.011) influenced the selection of the combination (Table 4.16). Results showed that the households that selected the combination had a TLU mean of 2.5 while those that did not select it had a mean of 2.4. This implies that an increase in the TLU in the household increases the probability of selection the combination. This could be because owning domestic livestock is considered as a source of wealth through the sales of the animals and their products like milk which can facilitate buying of fertilizers, while the animals themselves produce manure to be used in the combination. The findings agree with Odendo *et al*. (2010) who found that ownership of cattle is assumed to increase availability of manure and to generate income through sales of the cattle or its products and is thus hypothesized to accelerate adoption of manure and mineral fertilizers. Studies have shown that livestock ownership eliminates the constraints to up scaling of soil fertility management technologies (Kato *et al*., 2011). On the other hand some studies have shown a relationship between livestock and labour as factors that facilitate up scaling of soil fertility management practices (Lawal *et al.*, 2014).

4.5 The influence of farmers' participation in agricultural related group activities on their selection of SFE technologies

4.5.1: Participation in agricultural related activities in relation to selection of soil fertility enhancement technologies

A majority (25%) of the groups did self-help and merry-go-round as their main activities. Among the agricultural activities carried out by the groups included farming and natural resource management (16.7%), enterprise and marketing (3.3%) and dairying (1.7 %) (Table 4.17). This implies that self-help activities and merry-go-round activities are very important for group cohesion. These are activities that affect the core of the group, since they address both productive and reproductive activities of the households that form groups. When households participate in these group activities, they are able to stay together and synergize to enable sustainable agricultural production. Farmer groups are important in cases where farmers may not be able to access services due to SAPs (FAO, 2012). The farmer groups are able to collect farmers around a key objective and facilitate marketing, investments, information access and access to credit by farmers (Salifu *et al.*, 2010). Mbowa *et al.* (2012) also found out that women tended to join groups in order to purchase household items or for social insurance, while men often joined to gain market access or a coping mechanism. Over all, the main benefits derived from participating in agricultural groups activities are increase of farm income and ensuring food security (Figure 4.17)

Table 4.17: Various activities undertaken by farmer groups in Mbeere South and Maara sub-counties

Activities undertaken by the groups	Frequency	Percent
Self help	15.0	25.0
Merry go round	15.0	25.0
Risk coping	2.0	3.3
Forms of credit	13.0	21.7
Building of household assets	1.0	1.7
Enterprise and marketing	2.0	3.3
Farming and natural resource management	10.0	16.7
Dairying	1.0	1.7
Children's education	1.0	1.7
Total	60.0	100.0

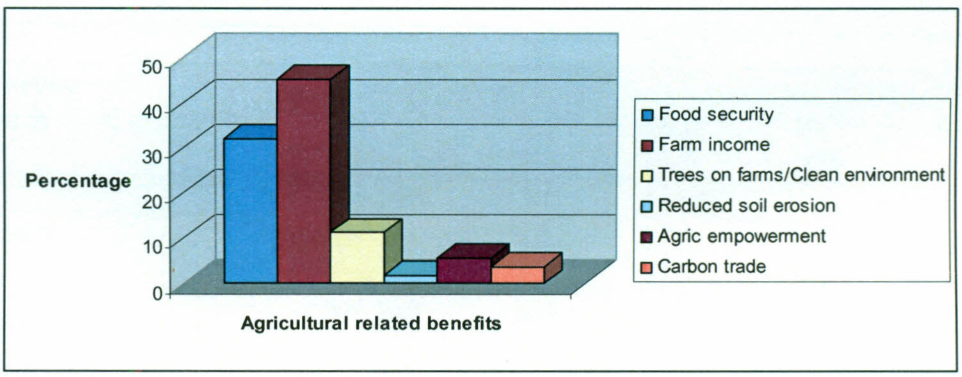

Figure 4.1: Main benefits of agricultural activities of the groups

4.5.2 Participation in Group Activities

There was a significant relationship between the participation in the group activities and the selection of a combination of animal manure + mineral fertilizer in Maara sub-county (χ^2=4.262, p=0.039), but not in Mbeere South sub-county (χ^2=1.281, p=0.258) (Table 4.18). Majority (97.4%) of the farmers who participated in the group activities in Maara sub-county selected a combination of animal manure + fertilizer as their soil fertility enhancement technology, while 5.1% of them that participated in the group activities in Mbeere South sub-county selected a combination of animal manure + fertilizer as their soil fertility enhancement technology. There was however no significant relationship between the participation in group activities in both Maara and Mbeere South sub-counties and the selection of animal manure and also no significant relationship between participation in group activities and the selection of the inorganic fertilizer.

Table 4.18: Participation in group activities and the use of manure, inorganic fertilizer, and a combination of animal manure + inorganic fertilizer in Mbeere South and Maara sub-counties

District	**Technology used 2010/11**	**Used the Technology**	**Participation in group activities**		**Total**	**χ^2 P value**
			No	Yes		
Mbeere South	Combination	No	1.4	98.6	100	0.258
		Yes	5.1	94.9	100	
		N= 109	**3.0**	**106.0**		
Maara		No	12.5	87.5	100	0.039
		Yes	2.6	97.4	100	
		N= 109	**6.0**	**103.0**		

This implies that participation in group activities increased the farmers' chances to take up the soil fertility inputs combination. A majority of the farmers (97.4%) of the farmers who participated in group activities in Maara sub-county selected a combination of manure plus fertilizer (Table 4.18). This could be because the average land sizes in Maara were smaller than Mbeere South, which increased the chances of farmers to meet as groups. The more the meetings, the more the chances of different ideas to come up, and the more the group activities developed and the more the chances of technology adoption. The selection of the combination could be attributed to the positive results associated with the combination of organic and inorganic sources of nutrients as has been found by various studies (Mwangi, 2010). This agrees with Carr (2010) who found that women's groups have worked well for women. Technology development and dissemination has been found to improve through farmer research groups and groups contributed to greater diffusion of information (Rathgeber, 2011). Farmers participating in local groups are likely to be more cohesive, a factor that may reduce the adverse effects of uncertainty of transactions and hence motivate participation and adoption of new technologies (Magreta *et al.*, 2010).

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The first objective was to assess the effect of farmer groups' characteristics on the choice of soil fertility enhancement technologies by individual members. Results showed that group characteristics had a significant influence on the application of manure. These included the group size, frequency of group meetings, meeting in public places and the number of women in the group while, Tropical Livestock Units and group formation prompt were the likely factors that influenced the application of fertilizer. On the other hand, education levels of group members, availability of manure, benefits of manure plus fertilizer and gender of the groups influenced the application of manure plus fertilizer.

The second objective sought to assess whether farmers' trainings have an influence on their decision to select soil fertility enhancement technologies. The results showed that soil fertility is a problem experienced at farm level in the study area, prompting farmers to seek trainings in large numbers. It was found to be true especially in influencing the use of a combination of manure plus fertilizer.

The third objective was to determine the influence of household characteristics of the farmers on the selection of SFE technologies. The characteristics that were found to positively influence the use of manure included the household size, Tropical Livestock Units, total land under food crops, and benefits of manure. On the other hand, household head education and land ownership with title had a negative influenced the use of manure.

The total land under food crops, household head education, availability of farm income and the time spent on the farm were identified as possible predictor factors likely to influence the use of manure. On the other hand, the use of manure plus fertilizer, total land under food crops, household head education, and Tropical Livestock Units were identified as possible predictor factors likely to influence the use of manure plus fertilizer.

The fourth objective was to assess the effects of participation of farmers in group activities on the selection of SFE technologies. The results showed that most of the groups did merry-go-rounds and self-help as their major activities. Participation in group activities was found to positively influence the selection of a combination of manure plus fertilizer.

5.2 Recommendations

- Any agency wanting to work with groups as concerns SFE technology uptake will need to work with groups of manageable sizes, which meet regularly in public places, and if possible have mixed gender in order to benefit from the interactions and synergies among themselves.
- Trainings are essential especially where the use of a combination of manure plus fertilizer is concerned. There is therefore need to intensify trainings of the farmers in the use of a combination of manure plus fertilizer. This will help farmers identify the right types of fertilizer for particular crops, the amounts to apply, how to apply and when to apply. Training farmers in groups will also capitalize the strengths of both the groups and information sources in order to increase benefits and cut technology dissemination costs. Trainings that have a

practical approach will enhance farmers understanding of SFE technologies even where formal education is a challenge.

- As government and other development partners endeavor to upscale the use of SFE technologies in communities, it will be important to consider some critical socioeconomic aspects such as household size, education levels, land sizes, availability of farm incomes and the number of livestock within the households among others.

- It is important to encourage farmers to join groups and participate in group activities. This helps them to draw from the synergies of the rest and there is a common benefit to all.

5.3 Areas for further Research

The time farmers take before adopting a new technology is a complicated process that may be affected by many factors, some of which vary with time, whilst others may not vary over time. Moreover, effects of most variables are often contradictory across technologies and study areas. There is therefore need to understand the underlying dynamics that can help improve strategies to speed up adoption of soil fertility management strategies.

If anyone would want to do some soil fertility work using groups and selected them using the already identified characteristics, it would be good to find out the impact of using such groups on the uptake and adoption of soil fertility technologies.

REFERENCES

Adolwa I. S., Esilaba A. O., Okoth P. O. and Mulwa M. R. (2010). Factors Influencing Uptake of Integrated Soil Fertility Management Knowledge Among Smallholder Farmers in Western Kenya. *Nutrient Cycling in Agroecosystems. Pg 1146-1152*

Adewole M.B. and Anyahara U. C. (2010). Adoption rate of land clearing techniques and their effects on some soil fertility parameters of an Alfisol in southwestern Nigeria, *African Journal of Agricultural Research, 5(23), 3310–3315*

Adong A., Mwaura F., Okoboi G. (2012). What Factors Determine Membership of Farmer Groups in Uganda? Evidence From the Uganda Census of Agriculture 2008/9. *Towards Sustainable Development. Economic Policy Research Centre (EPRC) (2012).*

Adong A., Mwaura F., & Okoboi G. (2013). What Factors Determine Membership to Farmer Groups in Uganda? Evidence from the Uganda Census of Agriculture 2008/9. *Journal of Sustainable Development; Vol. 6, No. 4*

Afolami S.O., Okeniyi M.O., Enikoumehin A.O., Popoola A.R., Aiyelaagbe & Fademi O.A. (2013). Plant-Parasitic Nematodes Associated With Old Cacao Plantations In Oyo And Ondo State Of Nigeria. *African Crop Science Conference Proceedings, Vol. 11. Pp. 407 – 411, © 2013, African Crop Science Society*

Agegnehu G., vanBeek C., and Bird M. I. (2014). Influence of integrated soil fertility management in wheat and tef productivity and soil chemical properties in the highland tropical environment *Journal of Soil Science and Plant Nutrition , 2014, 14, 532-545*

Agresti A. and Finlay B. (1997). Statistical Methods for the Social Sciences (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Ajayi O.C., Place F., Kwesiga F., Mafongoya P. (2007). Impacts of Improved Tree Fallow Technology in Zambia. In: Waibel H., Zilberman D. (Eds.), International Research on Natural Resource Management: Advances in Impact Assessment, *CAB International*: Wallingford, UK.

Ali L., Mangheni N.M., Saginga P.C., Delve R,J., Mastiko F., and Miiro R. (2007). Social Capital and adoption of soil fertility management technologies in Tororo District, Uganda. *Springer.Dordretch ,NL.p947-953*

Allahyari M. (2008) Extension mechanisms to support sustainable agriculture in Iran context. *American Journal of Agricultural and Biological Sciences, V.3 (4) : 647-655*

Alterra, Wageningen UR. (2010). Capacity Building for scaling-up of evidence-based best practices in agricultural production in Ethiopia (CASCADE). Wageningen: Alterra.

Alufah S., Shisanya C.A., and Obando J.A. (2012). Analysis of Factors Influencing Adoption of Soil and Water Conservation Technologies in Ngaciuma Sub-Catchment, Kenya. *African Journal of Basic & Applied Sciences 4 (5): 172-185*

Arifalo S.F. and Mafimisebi T.E. (2011). Assessment of the Effects of Soil Fertility Management Technologies on the Yield of Selected Food Crops in Oyo State, Nigeria. *Journal of Agricultural Technology* 7(1): 1-8.

Asante B.O., Sefa V.A., & Sarpong D.B. (2011). Determinants of small scale farmers' decision to join farmer based organizations in Ghana. *Africa Journal of Agricultural Research, 6*(10), 2273-2279.

ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa). (2010). Turning Knowledge into Action. Strategic Plan for the Knowledge Management and Up scaling Programme*, 2009–2014.ASARECA, Entebbe.*

Barham J. and Chitemi C. (2009). Collective Action Initiatives to Improve Marketing Performance: Lessons from farmer groups in Tanzania. *Food Policy Vol* 24:53-*59*. Available from: www.elsevier.com/locate/foodpol.

Barham J. and Chitemi C. (2008). Collective action initiatives to improve marketing performance: Lessons from farmer groups in Tanzania. *CAPRi Working Paper 74.* Washington, DC: IFPRI.

Barungi M., Ng'ong'ola D.H., Edriss A., Mugisha J., Waithaka M. andTukahirwa J. (2013). Factors Influencing the Adoption of Soil Erosion Control Technologies by Farmers along the Slopes of Mt. Elgon in Eastern Uganda. *Journal of Sustainable Development; Vol. 6, No. 2;*

Belay K. and Abebaw D. (2004). Challenge Facing Agricultural Extension Agents: A Case Study from South Western Ethiopia. *African Development Review, 16(1): 139-168.*

Bogdanski A., Dubois O., Jamieson C., and Krell R. (2010). Making Integrated Food-Energy Systems Work for People and Climate. *Environment and Natural Resources management Working Paper*. Food and Agriculture Organization of the United Nations, Rome

Bradbury A.S.C. (2006). Transport, mobility and social capital in the developing countries. Proceedings of the institution of civil engineers. *Engineering Sustainability. Issue ES2 pg 79-86*

Carr M. (2010). Lightening the Load. Labour saving technologies and practices for rural women. *IFAD and Practical Action Publishing.* 2010.

Chapagain T. and Gurung G. B. (2014). Effects of Integrated Plant Nutrient Management (IPNM) Practices on the Sustainability of Maize-based Hill Farming Systems in Nepal.

Chi T.T.N. (2008). Factors Affecting Technology Adoption among Rice Farmers in the Mekong Delta Through the Lens of the Local Authorial Managers: An Analysis Of Qualitative Data

Cobo J.D., Dercon G., Cadisch, G. (2010). Nutrient balances in African land use systems across different spatial scales: A review of approaches, challenges and progress. *Agricultural Ecosystems and Environment 136:1-15.*

Coenen G., Erceg C., Freedman C., Furceri D., Kumhof M., Lalonde R., Laxton D., Lindé J., Mourougane A., Muir D., Mursula S., de Resende C., Roberts J., Roeger W., Snudden S., Trabandt M. and in 't Veld J. (2010). Effects of Fiscal Stimulus in Structural Models. © *2010 International Monetary Fund*

Creative Research Systems (CRS), (2007). The Survey System: Sample Size Calculator: *Retrieved from http://www.surveysystem.com/sscalc.htm.* On 3rd February, 2013

Davis A.P., Gole T.W., Baena S., and Moat J. (2012). The Impact of Climate Change on Indigenous Arabica Coffee (Coffeaarabica): Predicting Future Trends and Identifying Priorities. *PLoS ONE 7(11): e47981. doi:10.1371/journal.pone.0047981*

Davis K. E. (2004). Technology Dissemination among Small-Scale Farmers in Meru Central District of Kenya: Impact of Group Participation. Doctor of Philosophy Thesis. University of Florida. 2004 (Unpublished)

Davis K., and Place N. (2003). Non-governmental organizations as an important actor in agricultural extension in semiarid East Africa. *Journal of International Agricultural and Extension Education* 10 (1): 31–36.

Davis K., Nkonya E., Kato D. A., Mekonnen M., Odendo R.M., and Nkuba J. (2010). Impact of Farmer Field Schools on Agricultural Productivity and Poverty in Uganda. *IFPRI Discussion Paper 00992 June 2010.*

Dorfman J.H. (1996). Modelling Multiple Adoption Decisions in a Joint Framework. *American Journal of agricultural Economics* 78: 547-557

Edmeades S., Phaneuf D.J., Smale M. and Renkow M. (2008). Modelling the Crop Variety Demand of Semi-Subsistence Households: Bananas in Uganda. *Journal of Agricultural Economics*, 2 (59): 329–349.

Eneku G.A., Wagoire W.W., Nakanwagi J. and Tukahirwa J.M.B. (2013). Innovation platforms: a tool for scaling up sustainable land management innovations in the highlands of Eastern Uganda. *African Crop Science Journal, Vol. 21, Issue Supplement s3, pp. 751- 760*

Farnworth C.R., and Obuya M. (2010). Gender Aware Approaches in Agricultural Programmes. *Kenya Country Report (A Special study of NALEP II).Sida.*

Faroque M.G. and Takeya H. (2009). Adoption of soil fertility and Nutrient management Approach: Farmers for teaching Methods in Bangladesh. *International Journal of Agriculture Research 4(1):29-37*

Fischer E. & Qaim M. (2012). Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya. *World Development, 40(6), 1255–1268.*

Food and Agriculture Organisation (FAO). (2010). Producer Organisations: Reducing opportunities for Development. *Policy brief.*

Food and Agriculture Organization of the United Nations. (2012). FAO, 2012: Country STAT Phase Project. *http://www.fao.org/economic/ ess/ess-capacity/countrystat/projects/en/*

Gebre T. and Weldemariam D. (2013). Farmers' perceptions' and participation on Mechanical soil and water conservation techniques in Kembata Tembaro Zone: the Case of Kachabirra *Woreda,* Ethiopia. *International Journal of Advanced Structures and Geotechnical Engineering Vol. 02, No. 04.*

Giller K.E., Witter E., Corbeels M. and Tittonel P. (2009). Conservation Agriculture and Smallholder Farming in Africa: The Heretics' view. *Field Crops Research, 144 (1), 23-34. doi:10. 1016/j.fcr.2009.06.017*

Gonsalves J., Becker T., Braun A., Campilan D., De Chavez D., Fajber E., Kapiriri M., Rivaca-Caminade J., and Vernooy R. (eds). (2005). Participatory Research and Development for Sustainable Agriculture and Natural Resource Management: A Sourcebook. Volume 3: Doing Participatory Research and Development. International Potato Center-Users' Perspectives With Agricultural Research and Development, Laguna, Philippines and International Development Research Centre, Ottawa, Canada.

Green F. (2003). Modelling Adoption of Soil Fertility Management and Conservation Practices. University of Pretoria etd – Tizale, C Y (2007)

Gwandu C., Tairo F., Mneney E. and Kullaya A. (2012). Characterization of Tanzanian elite sweet potato genotypes for sweet potato virus disease (SPVD) resistance and high dry matter content using simple sequence repeat (SSR) markers. *African Journal of Biotechnology Vol. 11(40), pp. 9582-9590, 17 May, 2012*

Gwandu T., Mtambanengwe F., Mapfumo P., Chikowo R., Mashavave T.C. and Nezomba H. (2014). Factors influencing access to integrated soil fertility management information and knowledge and its uptake among smallholder farmers in Zimbabwe. *Third RUFORUM Biennial Meeting 24 - 28 September 2012, Entebbe, Uganda*

Haan N. (2001). Of goats and groups: A study on social capital in development projects. *Agriculture and Human Values* 18:71–84

Hagerstrand T. (1966). Aspects of the Spatial Structure of Social Communication and the Diffusion of Information. Papers of the *Regional Science Association* 16:27-42

Halkos G.E. and Jones N. (2012). Modeling the effect of social factors on improving biodiversity protection. *Ecological Economics,* 78: 90-99

Han J., Han, Jian and Brass, D. (2014). Human capital diversity in the creation of social capital for team creativity. *Journal of Organizational Behavior, 35: 1, 54-71.*

Hill R.V., and Viceisza A. (2012). "A field experiment on the impact of weather shocks and insurance on risky investment." *Experimental Economics 15(2): 341–371.*

Hill M. (2011). National Agricultural and Livestock Extension Programme(NALEP)Study of the Implementation process .Thesis within political Science. JonKoping International Business School. JonKoping University.

Holcombe, S. (2012). Lessons from Practice: Assessing Scalability. Heller School for Social Policy and Management at Brandeis University, for the World Bank.

IAASTD (2009). Agriculture at a crossroads. International Assessment of Agricultural Knowledge, Science and Technology for Development. *Sub Sahara Africa (SSA) Report.*

ICRAF (2012). Trees, Livelihoods, Landscapes. © *World Agroforestry Centre*, Nairobi, Kenya, 2012

Jaetzold R., Schmidt H., Hornet Z.B. and Shisanya C.A. (2006). Farm Management Handbook of Kenya. Natural conditions and farm information. (2nd Edition). Vol.11/ C. Eastern Province. Nairobi, Kenya, Ministry of agriculture/GTZ.

Kabwe´G. (2010). Uptake of Agroforestry Technologies among Smallholder Farmers in Zambia. Degree of Doctor of Philosophy thesis. Lincoln University, Christchurch, Newzealand

Kassie M., Jaleta M., Shiferaw B., Mmbando F., and Mekuria M. (2014). Adoption of Interrelated Sustainable Agricultural Practices in Smallholder Systems: Evidence from Rural Tanzania. *Technological Forecasting and Social Change* 80: 525-40.

Kato E., Nkonya E., and Place F. (2011). An Econometric Investigation of Impacts of Sustainable Land Management Practices on Soil Carbon and Yield Risk A Potential for Climate Change Mitigation. International Food Policy Research Institute (IFPRI). *IFPRI Discussion Paper 01089*

Kilelu C.W., Klerkx L. and Leeuwis C. (2013). How Dynamics of Learning are Linked to Innovation Support Services: Insights from a Smallholder Commercialization Project in Kenya. *Journal of Agricultural Education and Extension*

Korir H.C., Lagat J.K., Mutai M.C. and Ali W.O. (2015). Influence of Social Capital on Producer Groups' Performance and Market Access Amongst Smallholder French beans Farmers in Kirinyaga County, Kenya. *Journal of Economics and Sustainable Development. Vol 6(2)*

Läpple D. and Van Rensburg T. (2011). Adoption of organic farming: Are there differences between early and late adoption? *Ecological Economics, 70*(7), *1406-1414.*

Larsen A.F., and Lilleor H.B. (2014). Beyond the Field: The Impact of Farmer Field Schools on Food Security and Poverty Alleviation. *World Development Vol. 64, pp. 843–859,*

Lawal A.F., Liman A. and Lakpene T. (2014). Adoption of Yam Minisett Technology by Farmers in Niger State, Southern Guinea Savannah, Nigeria. *Nigerian Journal of Agriculture, Food and Environment. 10(1):65-71*

Lickerman A. (2013). The true meaning of friendship: What is it that makes a true friend? *Psychology Today.* <http://www.psychologytoday.com/blog/happiness-in-world/201312/the-true-meaning-friendship>.

Liverpool S.L.O., and Winter-Nelson A. (2010). Poverty status and impact of social networks on smallholder technology adoption in Ethiopia. *IFPRI Discussion Paper. Washington DC.IFPRI 970*

Liverpool-Tasie S.L. (2012). Farmer groups, Input Access and intergroup dynamics. A case study of targeted subsidies in Nigeria. *IFPRI Discussion Washington DC.* International Food Policy Research Institute,P01197

Magreta R. Zingore S. and Magombo T. (2010). Analysis of effective market linkages in promoting investments in natural resource management in the rice-based farming system in Malawi. A case of Nkhate irrigation scheme. Available at http://hal.archives-ouvertes.fr/docs/00/52/34/64/PDF/RUTH_MAGRETA-_ISDA.pdf. Accessed on 17/01/2010.

Magreta R., Magombo T., and Zingore S. (2010). When the weak win: Role of farmers in influencing policy Outcome;a case of Nkhate irrigation scheme in Malawi. Poster presented at the 3rd African Association of Agricultural Economists (AAAE) and 48th *Agricultural Economist Association of South Africa (AEASA) conference*, Cape Town, South Africa, September, 19-23,2010

Magreta-Nyongani, M. (2012). "Mitigating Negative Externalities Affecting Access and Equity of Education in Low-Resource Countries: A Study Exploring Social Marketing as a Potential Strategy for Planning School Food Programs in Malawi" (2012). *Dissertations.* Paper 584.

Mahmoud E., Abd El-Kader N., Robin P., Akkal-Corfini N. and Abd El-Rahman L. (2009). Effects of different organic and inorganic fertilizers in cucumber yields and some soil properties. *World Journal of Agricultural Sciences 5(4): 408-414, 2009*. IDOSI Publications, 2009

Mbowa S., Shinyekwaand I. and Mayanja M. (2012). Dairy sector reform and transformation in Uganda since the 1990s. *EPRC Research Report No.4* Uganda.

Menon S.J., Anto J. and Sowmya C. (2012). Effectiveness of farmer groups-the case of Pananchery Farmers Club. *International Journal of Recent Scientific Research. Vol 3(2):86-90*

Milla M.T., Martínez-Vizcaíno V., Garcíal N.L., García-Prieto J.C., Arias-Palencia N. M. and García-Hermoso A. (2014). The relationship between beverage intake and weight status in children: The Cuenca study. *Social and Health Care Research Centre, University of Castilla-La Mancha, Cuenca, Spain. Nutr Hosp. 2014;30(4):818-824*

Mishra S.K., Gajbhiye S. and Pandey A. (2013). Estimations of design runoff curve numbers for Narmada watershed (India), *Journal of Applied Water Engineering and Reasearch, vol 1, no. 1, (2013), pp 67 – 79*

MoA & MoLD (2010). NALEP PHASE II Revised Project Document. Nairobi: Ministry of Agriculture & Ministry of Livestock Development.

Mugwe J., Mugendi D., Mucheru-Muna M., Merckx R., Chianu J. and Vanlauwe B. (2009). Determinants of the Decision to Adopt Integrated Soil Fertility Management: Practices by Smallholder Farmers in the Central Highlands of Kenya. *Expl Agric. (2009), volume 45, pp. 61–75 C* © 2008 Cambridge University Press

Murage A,W., Obare G., Chianu J., Amudavi D.M., Midega C.A.O., Pickett J.A., and Khan Z.R. (2012). The Effectiveness of Dissemination Pathways on Adoption of "Push-Pull" Technology in Western Kenya. *Quarterly Journal of International Agriculture 51, No. 1: 51-71*

Mustafa-Msukwa A.K., Mutimba J.K., Masangano C. and Edriss A.K. (2011). An assessment of the adoption of compost manure by smallholder farmers in Balaka District, Malawi. South Africa Tydskr. Landbouvoorl./*South African Journal of Agricultural Extension, Vol. 39, 2011: 17 – 25*

Mustisya T.W. (2010). Soil and Water Conservation in Kenya-Operations, Achievementsand Challenges of the National Agriculture and Livestock ExtensionProgramme (NALEP). *Journal of American Science.*

Mutuma S.P. (2013). Farmer perceptions, use and profitability of biofix® on soybean *(glycine max)* production in western Kenya .A Thesis Submitted in Partial Fulfillment of the Requirements for the Award of Master of Science Degree in Sustainable Soil Resource Management of the University of Nairobi

Mwangi E., Meinzen-Dick R. and Sun Y. (2011). Gender and sustainable forest management in East Africa and Latin America. *Ecology and Society 16(1): 17.* [online] URL: http://www.ecologyandsociety.org/ vol16/iss1/art17/

Mwangi N.S. (2011). The role of smallholder farmer groups in delivery of agricultural services for improved livelihoods in Murang'a district, Kenya (Thesis), Kenyatta University.

Mwaura F., Tungani J., Sikuku D. and Woomer P. (2012). Acceptability of cereal banks as a marketing intervention among small holder farmers in western Kenya. *Outlook on Agriculture, 41*(1), 35-40(6).

Mwaura F. (2014). Effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda. *African Crop Science Journal, Vol. 22, Issue Supplement s4, pp. 917 – 927*

Nata J.T. Mjelde J.W. and Boadu F.O. (2014). Household adoption of soil-improving practices

Ngwira A.R., Thierfelder C., and Lambert D.M. (2014). Conservation agriculture systems for Malawian smallholder farmers: long-term effects on crop productivity, profitability and soil quality. *Renewable Agriculture and Food Systems First View, 1-14.*

Nin-Pratt A.M., Johnson E., Magalhaes I., You X. Diao and Chamberlain J. (2011). Yield gaps and potential agricultural growth in central and West Africa. *Research Monograph.* IFPRI, Washington DC.

Nziguheba G., Palm C.A., Berhe T., Denning G., Dicko A., Diouf O., Diru W., Flor R., Frimpong F., Harawa R., Kaya B., Manumbu E., McArthur J., Mutuo P., Ndiaye M., Niang A., Nkhoma P., Nyadzi G., Sachs J., Sullivan C., Teklu G., Tobe L., and Sanchez P. A. (2010). The Africa Green Revolution: Results from the Millennium Villages Project. *Advances in Agronomy, Volume 109. ©2010 Elsevier Inc.*

Odendo M., Obare G. and Salasya B. (2010). Determinants of the Speed Of Adoption Of Soil Fertility- Enhancing Technologies In Western Kenya

Odendo M., Obare G. and Salasya B. (2011). What factors influence the speed of adoption of soil fertility management technologies? Evidence from Western Kenya. *Journal of Development and Agricultural Economics Vol. 3(13), pp. 627-637, ©2011 Academic Journals*

Ondieki-Mwaura F.N., Njoroge L.M., Okello J.J. and Bahemuka J.M. (2013). Determinants of participation in identified institutional arrangements in Kenya's export French bean sector. In *A paper presented at the 4th International Conference of the African Association of Agricultural Economists, Hammamet, Tunisia.*

Place F., Kariuki G., Wangila J., Kristjanson P., Makauki A., and Ndubi J. (2002). Assessing the Factors Underlying the Differences in Group Performance: Methodological Issues and Empirical Findings from the Highlands of Central Kenya, November 2002.

Place F., Kariuki G., Wangila J., Kristjanson P., Makauki A. and Ndubi J. (2004). Assessing the factors underlying differences in achievements of farmer groups: methodological issues and empirical findings from the highlands of Central Kenya. *Agricultural Systems* 82:257–27

Quisumbing A. and Pandolfelli L. (2008). Promising Approaches to Address the Needs of Poor Female Farmers. *International Food Policy Research Institute. Note 13*

Rathgeber E.M. (2011). Rural Women's Access to Science and Technology in the Context of Natural Resource Management. Expert Group Meeting Enabling rural women's economic empowerment: *Institutions, Opportunities and Participation,* Accra, Ghana, 20-23 September 2011

Reddy S.K., Mohanty M., Rao D.L.N., Rao S.A., Pax C Blamey F., Dalal R.C., Dixit S.K., Pandey M. and Menzies N.W. (2010). Development of farmers' participatory integrated nutrient management technology using the Mother – Baby Trial approach, 19th World Congress of Soil Science, Soil Solutions for a Changing World 1 – 6 August 2010, Brisbane, Australia.

Republic of Kenya. (2011). Ministry of agriculture, Farm Inputs Division 2011. Government Printer. Nairobi,Kenya.

Rogers E.M. (1983). Diffussion of innovations. Free Press. New York. U.S.A.

Salifu A., Francesconi G.N., and Kolavalli S. (2010). A Review of Collective Action in Rural Ghana. *IFPRI Discussion Paper 00998.*

Sanginga N. and Woomer P.L. (Eds.) 2009. Integrated soil fertility management in Africa: Principles, practices and developmental process. *Tropical Soil Biology and Fertility Institute of the International Centre for Tropical agriculture*. Nairobi. 263 pp.

Sanginga P.C., Lilja N.K. and Tumwine J. (2005). Assessing the Quality Of Participation in Farmers' Research Groups in the Highlands Of Kabale, Uganda. *PABRA Millennium Workshop.* Tanzania.

Seiwald M. (2014): The (up) scaling of renewable energy technologies: Experiences from the Austrian biomass district heating niche. *Moravian Geographical Reports, Vol. 22, No. 2, p. 44–54.* DOI: 10.2478/mgr-2014-0011.

Sommer R., Bossio D., Desta L., Dimes L., Kihara J., Koala S., Mango N., Rodriguez D., Thierfelder C., and Winowiecki L (2013). Profitable and Sustainable Nutrient Management Systems for East and Southern African Smallholder Farming Systems– Challenges and Opportunities. University of Queensland, CIMMYT and CIAT.

Tanguy B. Taffesse and Alemayehu S. (2012). 'Returns to Scope? Smallholders' Commercialisation through Multipurpose Cooperatives in Ethiopia', *African Economies' 21(3)* (March): 440–64. The Montpellier Panel: Sustainable Intensification: A New Paradigm for African Agriculture. London: Agriculture for Impact, Imperial College; 2013:1–36.

Toenniessen G., Adesina A. and Devries J., (2008). Building an Alliance for a Green Revolution in Africa. Ann. N.Y. *Academics and Science 1136: 233–242.*

UNEP (2012). Africa environment outlook:Past, present and future perspectives. UNEP,Nairobi

Vanlauwe B., Chianu J., Giller K.E., Merckx R., Mokwunye U., Pypers P., Shepherd K., Smaling E., Woomer P.L. and Sanginga N. (2010). Integrated soil fertility management: operational definition and consequences for implementation and dissemination. p. 194-197 in: 2010 19th *World Congress of Soil Science, Soil Solutions for a Changing World* 1–6 August 2010, Brisbane, Australia.

Vellema S. and Helmsing B. (2011, April). Development impacts of value chain interventions - a knowledge agenda. *VC4PD Policy Brief 12*. DPRN.

Wennink B. and Heemskerk W. (Eds). (2006). Farmers' Organizations and Agricultural Innovation. Case studies from Bennin, Rwanda and Tanzania. *Royal Tropical Institute (KIT)*, Amsterdam, The Netherlands. *Bulletin 374. 2006*

Wollni M., Lee D. R. and Thies J. E. (2010). Conservation agriculture, organic marketing, and collective action in the Honduran hillsides, *Agricultural Economics 41(2010): 373–384*

Wollni M., and Andersson C (2013). Spatial patterns of organic agriculture adoption: evidence from Honduras. *Selected Paper prepared for presentation at the AEL (Research Committee on Development Economics) Conference, Munich, June 21-22, 2013.*

Wopereis M., Johnson D., Ahmadi N., Tollens E. and Jalloh A. (eds.), (2010). Realizing Africa's Rice Promise. Pp. 355-366. Wallingford, UK: *CABI* Publishing.

World Bank (2012). Gender Equality and Development. World Development Report. 2012

Zeleke G., Agegnehu G., Abera D. and Rashid S. (2010). Fertilizer and soil fertility potential in Ethiopia: Constraints and opportunities for enhancing the system. IFPRI, Addis Ababa, Ethiopia, 63p.

Zhou D and Grumbine R.E. (2011). National parks in China: experiments with protecting nature and human livelihoods in Yunnan province, People's Republic of China. *Biological Conservation,* 144 (5).

Zhou Y., Yang H., Mosler H.J. and Abbaspour K.C. (2010). Factors affecting farmers' decisions on fertilizer use: A case study for the Chaobai watershed in Northern China . *Consilience: The Journal of Sustainable Development Vol. 4, Iss. 1 (2010), Pp. 80–102*

APPENDICES

Appendix I- Farmer Group Survey

Farmer Groups' Survey

Dear Sir/madam

*I am carrying out the study entitled "***The influence of farmer groups' characteristics on the selection of soil fertility enhancement technologies in the central highlands of Kenya***", Being one of our stakeholders/collaborators, you have been selected to participate in this study. The information you give will be used only for research purpose and will be confidential. Kindly make your responses as truthful and sincerely as possible.*

Thank you

Frashiah Mwebia

Kenyatta University

Questions are addressed to the farmer group
Enumerator's Name: ______________________________
Date of interview________________________
Time interview started __________

Core var. no	**Variable label**	**F/A**	**Variable values and rules**	**Skip-rules, information, remarks**
	1. Demographic Characteristics			
1.	District			
2.	Division			
3.	Location			
4.	Sub-Location			
5.	Village			
	2. Group characterization			
6.	Farmer group number			All groups should be given a number.
7.	Name of the group			
8.	Date of group formation			
9.	Is your group registered with the ministry of culture and social services?		*1=Yes, 2= No*	
10.	When was the group registered?		*(Indicate year)*	
11.	Does your group have a constitution and by-laws?		*1= Yes, No*	
12.	Does your group have a bank account?		*1= Yes, No*	
13.	What is the group registration number?			
14.	How many Male members do you have			
15.	How many Female members do you have			

3. Group activities				
16.	What prompted the group's formation?		*1=External organizations' involvement (Cash or material injection or promises of the same) 2=Internal issues (Problems and challenges within the community members)*	
17.	What was your main/major purpose immediately after you started the group?		*1=Self-help, 2= Merry-go-round, 3= Risk copping strategies, 4= Forms of credit, 5= Building of household assets, 6= Enterprise and marketing, 7= Farming and natural resource management, 8=Dairying, 9=Others (Specify)*	The response should be one
18.	What activities does the group undertake now?		*1=Self-help, 2= Merry-go-round, 3= Risk copping strategies, 4= Forms of credit, 5= Building of household assets, 6= Enterprise and marketing, 7= Farming and natural resource management, 8=Dairying, 9=Value addition, 10= Others (Specify)*	
19.	What resources/assets does the group have?		*1=Animals, 2=Farm implements, 3=Cash in bank, 4=Household items for hire, 5=Others (Specify)*	More than 1 value is acceptable
Please give an estimate of the resources owned by the group				
19.1	**Resource**	**Quantity**	**Value**	
19.2	Animals			
19.3	Farm implements			
19.4	Cash			
19.5	Members farm size contributions(Acres)			

20.	What is the motivation behind the activities you undertake now?		*1=All in the group are equally empowered, 2=A group member can never be stranded, 3=When group members work as one, external stakeholders are attracted, 4=Others (Specify)*
21.	If the group activities are different now, what prompted the change?		*1=Trained and saw need to change direction, 2=New programes /project came into the area, 3=Challenges within the group itself/community, 4=Purely group decision, 5=Others (Specify)*
22.	Who are the other stakeholders/ collaborators in your group activities		*1=KARI , 2= MoA, 3=KU, 4=Ministry of gender and social services, 5= Administration, 6= Others (Specify)*
23.	What benefits have you got from the linkages if any?		*1=Training, 2=Material farm inputs, 3=Cash for farm inputs, 4=Loans (Credits, 5=Others (Specify)*
24.	What is your goal as a group now?		
25.	What has been the trend in group membership with time?		*1= Decreasing, 2= Increasing*
25.1	If there is a change, what do you think is the major cause?		
	1=Could not cope with the group contributions, 2=Could not cope with the group regulations, 3= Group activities a challenge, 4=New group direction a challenge, 5=Availability of external support, 6=Availability of group guarantee for credits, 7=Availability of opportunities through collaborators, 8= Others (Specify)		
26.	Are there challenges faced because of large numbers?		*1=Yes___ 0=No___*
27.	Are there challenges faced because of small numbers?		*1=Yes___ 0=No___*
28.	If there are, indicate two major challenges starting with the most i)______________________ ii)______________________		*1= Discipline, 2= Group management (Cohesion), 3= Marketing activities 4= Production activities, 5= External influences, 6= Homogeneity, 7=Information dissemination, 8= Individual commitment/participation, 9=Meeting members' expectations 10=Individual benefits, 11=Others (specify)*
29.	Are there activities that your group prefers to join other groups in doing?		*1=Yes, 2=No*

30.	If yes, which ones?		*1= Agricultural produce marketing, 2=Farming & natural resource management, 3=Dairying, 4=Training, 5=Risk copping strategies, 6=Others (Specify)*	Give your best option
31.	What activities would you prefer to do alone as individual farmers away from the group?		*1= Forms of credit, 2=Building of household assets, 3= Agricultural produce marketing, 4=Dairying, 5=Risk copping strategies, 6= Others (Specify)*	
32.	How often have you participated as a group in **field days?**		*1=None, 2=1-3Times, 3=4-5 times, 4=Over 5 times*	*Tick one*
33.	How often have you participated as a group in **demonstrations?**		*1=None, 2=1-3Times, 3=4-5 times, 4=Over 5 times*	
34.	How often have you participated as a group in **agric. shows?**		*1=None, 2=1-3Times, 3=4-5 times, 4=Over 5 times*	
35.	How often have you participated as a group in **agric. tours?**		*1=None, 2=1-3Times, 3=4-5 times, 4=Over 5 times*	

4. Soil fertility and technologies				
36.	**What technologies are preferred by men and women?** Animal manure *(Indicate 1 or 2)*		*1=Males, 2=Females*	
37.	Inorganic fertilizer			
38.	Combination(Specify)			
39.	Legume intercrop			
40.	Others (Specify)			

What has been the impact of group training activities on the following?

41.	**ISFM**	**Number of farmers trained**	**Number of male farmers benefited**	**Number of female farmers benefited**	**Main benefits realized**
42.	Animal Manure				
43.	Inorganic fertilizer				
44.	Combination(Specify)				
45.	Legume intercrop (Specify)				

46.	Tithonia					

47.	**What constraints have you encountered as you tried the following technologies;**		*1= Farm size, 2= Labour demand, 3= Lack of edible products, 4= Inaccessibility to credit, 5= No noticeable yield increase, 6= Lack of market for the produce, 7=Costly*	
48.	Animal Manure			
49.	Inorganic fertilizer			
50.	Combination(Specify)			
51.	Legume intercrop			
52.	Others (Specify)			

5. Group meetings				
53.	Are minutes taken during the meetings?		*1=Yes, 2=No, 3=Not always*	
54.	Which are the common agenda in the meetings?		*1=Planning for trainings, 2=Contributions/benefits, 3=Addressing challenges, 4=Investments*	
55.	Where are the venues for the meetings?		*1=Group venue (farm) 2=Rotate members' homes 3=Church 4=School 5=Shopping centre 6= Others (Specify)*	
56.	Are these venues appropriate?		*1=Yes, 2=No*	If no, give a recommendation
57.	What are the financial contributions in your meetings?		*1=Yes, 2=No*	
58.	Does the executive meet regularly?		*1=Yes, 2=No*	
59.	If yes, how often?		*1=Weekly 2= Fortnightly 3=Monthly 4= Quarterly 5=When need be 6=Never*	
60.	Which decisions of the group does the executive make?		*Indicate*	
61.	Which decisions of the group do the group members make?		*Indicate*	
62.	Has the group pursued a different direction?		*1=Yes, 2=No*	If yes, which one? And why?
63.	What is the basis/qualification for membership in your group?		*1= Age, 2= Education levels, 3= Religion, 4= Wealth levels, 5= Family relations, 6= Others*	

6. Group activities and impacts

Agricultural activities	Non- agricultural activities

List the 5 main agricultural activities of the group	List main impacts	Number of group farmers benefited	List the 5 main non-agricultural activities of the group	List main impacts	Number of group farmers benefited

7. Group potential for scaling up, sustainability, diversification and growth

7.1) Will your group contribute to lasting future benefits or impacts in your area? __________[1=Yes, 0= No]

7.2) Do you have plans to diversify, change, modify, scale down, or continue your activities or plans in the future?

7.3) What are the main strengths of the group?

7.4) What are the main weaknesses of the group?

Please list in table the future plans of 5main activities or products or projects

Future plan	**List product/ activities/ technologies**			
	Product 1	**Product 2**	**Product 3**	**Product 4**
Diversify- increase activity				
Scale up activity				
Scale down activity				
Continue as present				
Major change				
Remove activity/ product				
Introduce new activity				

Appendix II – Household Survey

HOUSEHOLD SURVEY

Dear Sir/madam

I am carrying out the study entitled "The influence of farmer groups' characteristics on selection of soil fertility enhancement technologies in the central highlands of Kenya*", Being one of our stakeholders/collaborators, you have been selected to participate in this study. The information you give will be used only for research purpose and will be confidential. Kindly make your responses as truthfully and sincerely as possible.*

Questions are addressed to the household head/farm decision maker who should preferably be the respondent

Thank you
Frashiah Mwebia
Kenyatta University

Enumerator's Name: ____________________Date of interview__________________; Time interview started _____________;
District----------------Division; ----------------- Sub-location; ----------------Village: ---------;
HH Number_______________________; Name of HH head---; Mobile phone------------

1. Composition and characteristics of the household

Member		**Age**	**Sex**	**Number of years in school**	**Years of farming experience**	**Crop farming activities involved in**	**Months in a year spent on the farm**
Household head	1.						
Other adults (> 15 years)	2.						
	3.						
	4.						
	5.						
Children (≤ 15 years)	8.						
	9.						
	10.						
	11.						

1.2) Gender of household head (Decision maker of farm operations) [*Male=1, Female=0*]
1.3) Educational level of Household Head? [*1=No education, 2=Primary Education, 3=Secondary, 4=Tertiary education (Specify)*]
1.4) Household head main occupation [*1=Farming, 2=Business, 3=Formal Employment, 4= Others (Specify)*]
1.5) Spouse's occupation *[1=Farming, 2=Business, 3=Formal Employment, 4= Others (Specify)]*
1.6) Household size Male adults___, Female adults___ Male children______Female children
1.7) Marital status of hh head [*1=Window, 2=Widower, 3=Separated, 4=Married (Absent spouse), 5= Married (Present spouse), 6= Single]*

2.0 Farm characteristics

1	What is the total land available to the household? (acres)	
2	How much of your land is cultivated? (acres)	
3	How much land is under food crops (acres)	
4	Under what land tenure system do the HH operate?	*1=Owned without title deed* *2=Inherited land with title deed* *3=Purchased land with title deed* *4=Borrowed/rented/leased land*

2.1 Please provide the following information on your crop activities

Crop	**Size of plot allocated to crop *[Acres]***	**Is ISFM used on these crops [1= Yes, 0= No]**	**Estimated last season crop yield [Kg]**	**Main farming objective *[1= Subsistence, 2= Market]***

3. 0 Group Member Characteristics

Group (Indicate name of your group)	Main group activity [1=Self help, 2=Merry-go-round, 3=Risk copping strategies, 4=Forms of credit, 5=Building of household assets, 6=Enterprise and marketing, 7=Farming and natural resource management, 8=Dairying, 9= Others (specify)]	Main group benefits [1=Financial, 2=Social support, 3=Trainings]

3.1) Do you hold a position in the group? [*1=Chairperson, 2=Secretary, 3=Treasurer, 4=Committee member, 5= Ordinary member*]

3.2) Does the group help you solve your soil fertility problems? (1= Yes, 0= No)

3.3) If yes how and why?

3.4) How do you expect the group to help you solve soil fertility problems?

3.5) According to you, what factors hinder the formation or running of farmer groups in your area?

3.6) Do you belong to more than one group? (1= Yes, 0= No).

3.7) If yes, why [*1=Diversify the activities I am involved in, 2=Take advantage of various financial contributions, 3=Access more credits, 4=Make better use of my available time, 5= Others (Specify)]*

3.8) How many other groups do you belong to_________.

3.9) How did you learn about the advantages of groups? [*1= Other farmers, 2=Extension agents, 3=NGO, 4=Administration, 5=Others (Specify)*]_______

3.10) Have you benefited from being a group member? [1= Yes, 0= No]

3.11) How far is the mother site from the normal group training ground? **(Approximate in km) _____km**

3.12) **How long do you take to get to the trainings at the demonstration site?** [*1=Less than 20 minutes, 2=20 minites-1 hr, 3=1-2 hrs 4=Over 2 hrs*]

3.13) How does the distance to demo site affect your group performance? [*1=Some people arrive late, 2=Some are unable to attend trainings, 3=Some people miss part of the training, 4=Some people arrive very tired and cannot grasp everything*]

3.14) How often does your group meet? [*1=Weekly, 2=Fortnightly, 3= Monthly, 4=Quarterly 5=circumstantial on need basis]*

3.15) What types of meetings are held? [*1=General, 2=Executive*]

3.16) What is your average attendance during the meetings?
*Male*________*Female*_______

4.0 Gender

4.1) Are there technologies that are preferred by certain gender?
4.2) If yes, which are they?
4.3) If yes, why?
4.4) Are there technologies whose levels of application depend on gender?
4.5) If there are, which ones?
4.6) If there are, why?

5: Group Training.

What type of trainings have you received as a group member of the group? [*1= Soil fertility 2=Group dynamics and leadership, 3 Crop & livestock production, 4= agricultural produce marketing, 5= Value addition 6=Cross cutting issues* 7= Others (Specify)]. List beginning with the most current___________________________

Type of training	**Number of trainings**	**Frequency of training** (*1= Weekly, 2 Monthly, 3= Seasonal*)	**Who trained the group** *(See codes)*	**Methods used to train** (*Choose the most effective method)*	**Training duration (1=1-2hrs, 2=2-5hrs, 3=5-8hrs, 4=1-2days, 5=3-5days)**	**Training venues (see codes)**

		ly, 4= Yearly)				
Soil fertility related training						
Group dynamics and leadership						
Production related trainings (Crop & livestock)						
Agricultural produce marketing						
Value addition						
Cross cutting issues related trainings						
Others:						

***Who trained the group** (1= Agricultural agents, 2= Agro-input dealers, 3= The market, 4= Relatives/friends/inherited from parents, 5= Traders, 6= Researchers, 7= NGO's, 8= TV & radio, 9= Print media (Newspapers etc));*

***Training methods** (1= Mother-baby, 2= Individual farm visits, 3= Farmers' baraza, 4= Farmer groups, 5= FFS, 6= Demonstrations, 7= Farmers' exchange visits/tours, 8= Farmers' workshops, 9= Farmers' seminars, 10= Farmers' field days, 11= Sows/exhibitions, 12= Mass media, 13= Print media, 14= Information desk)*

***Venues used to train farmers** (1= Farm, 2=Classroom, 3=Church, 4=Open field , 5= Others)*

Type of training	Training venue	Who initiated training (see codes)	Any contribution to training *(1= Yes, 0=No)*	Specify contribution to training	Were trainings adequate? (1= Yes, 0= No)
Soil fertility related training					

Group dynamics and leadership					
Production related trainings (Crop & livestock)					
Agricultural produce marketing					
Value addition					
Cross cutting issues related trainings					
Others:					

***Who initiated training** (1=Trainers, 2=Group leaders, 3=Group members)*

5: Group Training contd…

Type of training	What were the results/ impacts of training (see codes)	Do you need any more training (1= Yes, 0= No)	Specific area for more training
Soil fertility related training			
Group dynamics and leadership			
Production related trainings (Crop & livestock)			
Agricultural produce marketing			
Value addition			
Cross cutting issues related trainings			
Others:			

***Training impacts** 1=More protected farms, 2=Reduced soil erosion, 3=More cohesive groups, 4=Access to better markets, 5=Higher farm incomes, 6=Improved yields*

6. Education levels			
6.1	Which languages do you know?		*1=English, 2=Kiswahili, 3=Vernacular, 4=Others (Specify)*
6.2	Which languages do you read?		*1=English, 2=Kiswahili, 3=Vernacular, 4=Others (Specify)*
6.3	What is your highest level of education attained?		*1=no education, 2=primary education, 3=secondary education, 4=tertiary education (Specify)*

6.4	How many members of your group share your education level?		
6.5	Do you face challenges related to your education levels?		*1=Yes, 2=No*
6.6	If yes, which ones?		
6.7	If they are there, how do you try to overcome them?		
6.8	Are there soil fertility technologies you know about and have not been trained on?		

7 . Soil fertility status			
7.1	According to you, what is the soil fertility level of your farm?		*1=High, 2=Medium, 3=Low, 4=Do not know*
7.2	Proportion of farm with high soil fertility (%)		
7.3	Proportion of farm with medium soil fertility (%)		
7.4	Proportion of farm with low soil fertility (%)		
7.5	What soil fertility technologies have you been exposed to?		*1= Animal manure application, 2=Inorganic fertilizer application, 3=Combination, 4= Compost manure application,, 5= Use of legumes (Intercrops), 6=Use of green manures, 7=Others (Specify)*
7.6	What technologies do you practice on your farm? *(Opt for the best)*		*1= Animal manure application, 2=Inorganic fertilizer application, 3=Combination, 4= Compost manure application,, 5= Use of legumes (Intercrops), 6=Use of green manures, 7=Others (Specify)*
7.7	Why do you prefer the following technologies?		*1=Cost involved, 2=Availability, 3=Ease of application, 4=Frequency of application, 5=Labour demand*
7.8	Animal manure application		
7.9	Mineral fertilizer application		
7.10	Combination		
7.11	Compost manure application		
7.12	Use of legumes(Intercrop)		
7.13	Use of green manures		
7.14	Others (Specify)		

8. ISFM utilization

ISFM	Have you used the technology for the last 1 year (1= Yes, 0= No)	How much land is allocated to ISFM (Acres)	How do you rate the performance of the technologies	For the technologies not selected, what are the reasons?	What benefits are associated with the technologies (List)):
Animal manures					
Mineral fertilizer					
Combinations					
Compost					
Legume intercrops					
Green manures					
Others (Specify)					

Technology performance (*0=Very poor, 1=Poor, 2=Fair, 3=Good, 4=V. good)*

Reasons for not selecting technologies (*1=Expensive, 2=Unavailability, 3=Hard to apply, 4=Applied frequently of application, 5=Labour demand is high*)

8. ISFM utilization contd….

ISFM	**Where did you get the knowledge on the technologies from? (see codes below)**	**Which was the most effective method used to teach you about the technologies?**
Animal manure		
Mineral fertilizer		
Combination of organics and inorganic		
Legumes(Intercrop)		
Agroforestry trees		
Others (specify)		

Where got technologies from: (1=Extension agents, 2=Agro-input dealers, 3=The market, 4=Relatives/friends/inherited from parents, 5=Traders, 6=Researchers, 7=NGOs, 8=TV & radio, 9=Print media (News papers)

Most effective teaching method; (1=Mother-baby, 2=Individual farm visit, 3=Farmers' baraza, 4=Farmer groups, 5=FFS, 6=Demonstrations, 7=Farmers' seminars, 8=Farmers' workshops, 9=Farmers' seminar, 10=Farmers' field day, 11=Shows/exhibits, 12=Mass media, 13=Print media, 14=Information desk)

Appendix III – List of farmer groups

List of farmer groups

No	Group Name	Sub-County	Division	Village
1	Gachoka Prayer	Mbeere South	Mbeti South	Gachoka
2	JJ Thayu	Mbeere South	Mbeti South	Kangami
3	Kamucii	Mbeere South	Mbeti South	Kanthenge
4	Kamugaa FFS	Mbeere South	Mbeti South	Ngangari
5	Kamwonga	Mbeere South	Mbeti South	Kanyariri
6	Kamurata	Mbeere South	Mbeti South	Gachoka
7	Kandogo	Mbeere South	Mbeti South	Kandogo
8	Kangami	Mbeere South	Mbeti South	Kangami
9	Kangungi child	Mbeere South	Mbeti South	Kangungi
10	Gachoka FFS	Mbeere South	Mbeti South	Muraru
11	Kanina-Wa-Nthga Teachers	Mbeere South	Mbeti South	Gachoka
12	Kiiyo	Mbeere South	Mbeti South	Kangungi
13	Kimuri	Mbeere South	Mbeti South	Kangungi
14	Mangika	Mbeere South	Mbeti South	Muraru
15	Mother-to-mother	Mbeere South	Mbeti South	Gachoka
16	Mtukumbuke	Mbeere South	Mbeti South	Mutugu
17	Mufasa	Mbeere South	Mbeti South	Kambiti
18	Mukiangu	Mbeere South	Mbeti South	Ivinge
19	Munyaka	Mbeere South	Mbeti South	Muraru
20	Muraru Wendani	Mbeere South	Mbeti South	Muraru
21	Mwangaza	Mbeere South	Mbeti South	Nguru
22	Mwende	Mbeere South	Mbeti South	Kangungi
23	Mwirutiri	Mbeere South	Mbeti South	Kandogo
24	Ngangari Adult	Mbeere South	Mbeti South	Ngangari
25	Nguria-Ngukurie	Mbeere South	Mbeti South	Ivinge
26	Nuru	Mbeere South	Mbeti South	Kanduu
27	Precious Grace Muraru	Mbeere South	Mbeti South	Muraru
28	Riandama	Mbeere South	Mbeti South	Rianjeru
29	Umoja	Mbeere South	Mbeti South	Nguru
30	Utugi	Mbeere South	Mbeti South	Kangeta
31	Caribean	Maara	Ganga	Katurini
32	Gakenia	Maara	Ganga	Mukui
33	Gichure	Maara	Ganga	Ngeru
34	Gitiru Youth	Maara	Ganga	Kathima
35	Kaageni	Maara	Ganga	Kathurini
36	Kajiumia	Maara	Ganga	Ntatua
37	Kamucii	Maara	Ganga	Murunga
38	Kamwingi	Maara	Ganga	Mukui
39	Kanini	Maara	Ganga	Kathima
40	Kanoo	Maara	Ganga	Kanoo
41	Karimi Mukoma	Maara	Ganga	Ngaita
42	Karinga-Ka-Ari	Maara	Ganga	Mukui
43	Kathurini	Maara	Ganga	Kathurini
44	Kawendo	Maara	Ganga	Ndundo
45	Kiaburi	Maara	Ganga	Kiaburi

46	Kiamaogo	Maara	Ganga	Kiamaogo
47	Kiriani Farmers	Maara	Ganga	Kiriani
48	Kiriguni	Maara	Ganga	Mukui
49	Makena	Maara	Ganga	Mukui
50	Mbironi Wendani	Maara	Ganga	Mbironi
51	Mugumango Elders	Maara	Ganga	Mukui
52	Mukui KWFT	Maara	Ganga	Ndundo
53	Mukui Teachers	Maara	Ganga	Mukui
54	Mutwoboro	Maara	Ganga	Kanoo
55	Neema	Maara	Ganga	Mukui
56	New Kithare	Maara	Ganga	Kiriti
57	Ngaeni	Maara	Ganga	Kathima
58	Nkangani Youth	Maara	Ganga	Nkangani
59	Peasant	Maara	Ganga	Mukui
60	Utugi Youth	Maara	Ganga	Kanoo