IMPACT OF SOIL AND CROP MANAGEMENT TECHNOLOGIES PROMOTED THROUGH FARMER FIELD SCHOOLS ON FARMING SYSTEMS AND PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN NORTH RIFT VALLEY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

I hereby declare that this thesis is my original work and that it has not been submitted in this or any other form for an award of a degree in this or any university.

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Recommendation

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DEDICATION

To my beloved wife Emily Kangogo Bunyatta, my daughters, Moureen Jepchirchir, Marion Jeptepkeny and son Master Emmanuel Kiprop for their great love, support, patience and understanding during my study period. To my beloved father, the Late Mzee Silotei Arap Kogo Kapbunyatta, my mother, the Late Martha Silotei Bunyatta and My eldest sister the Late Drusila Mesis for their love, sacrifice, encouragement and care since my childhood through the years I have been in school. Thanks for having educated me. To my late brother in law the Late Henry Cherono for the desire and encouragement to me to accomplish this work. To my sisters, brothers, cousins and friends for their love and moral support. Last but not least to all sons and daughters of “Kibirong” clan members who will aspire to climb the ladder of academics and achieve higher level of education.

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ABSTRACT

Conventional Extension Approaches used over decades achieved minimal successes in creating impact in terms of agricultural production and improved livelihood of smallholder farmers in Kenya. The Participatory Extension Approaches, in particularly the Farmer Field School (FFS) approach have been tried widely and created positive impact in Asian countries. Kenya Agricultural Research Institute (KARI) introduced FFS approach in 2001 as an alternative to conventional approach to promote dissemination of Soil and Crop Management Technologies (S&CMT). Since the introduction of the FFS approach in the study locations, no impact studies have been undertaken to document its importance in comparison with the conventional extension approach. The purpose of this study was to determine the impact of the S&CMTs disseminated through FFSs on the Farming Systems (FS) and productivity among the smallholder farmers in North Rift, Kenya. A survey methodology with an *Ex-post facto* research design was used with a sampling frame consisting of 6,560 small-scale farmers. A sample of 180 FFS and 180 Non-FFS farmers (360 persons) was chosen for the study, using random sampling. The dependent variable for the study was impact of Soil and Crop Management Farmer Field Schools (S&CMFFSs) and was operationalised into the FS and productivity variables. The FS variables were the level of change in farm practices, knowledge and skills acquired in S&CMTs and level of household income. The productivity variables included the level of soil and crop management reflected in the level of production per unit area for maize. The independent variables were the S&CM FFS and conventional extension approaches used in farmer training and dissemination of S&CMTs. Moderator variables were socio-economic factors of the respondents. Data was collected through interview schedules administered to FFS and Non FFS farmers. Descriptive statistics was used to compute percentages, means and standard deviations. Inferential statistics used included multiple regression, t-test and one way analysis of variance. Hypotheses were tested at α 0.05. Data was analysed using Statistical Package for Social Scientists (SPSS). The results indicated that there were significant differences ($P<0.05$) in knowledge acquired in S&CMTs, productivity, FS and impact of S&CMTs between FFS and non-FFS participants. The results further indicated that 57.6% ($R^2 = 0.576$) of the variation in the depended variable of impact of S&CMTs is explained by the socio economic factors in the equation. It was concluded that farmers who were exposed to the FFS training had a better understanding, adoption, practice (FS), Productivity in terms of yield and income and hence higher impact of S&CMTs as as compared to the non-FFS farmers. The main recommendation from this study was therefore, the need to scale-up and scaling out the S&CMTs using the using the FFS approach to more counties in the North Rift region of Kenya.

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LIST OF ABBREVIATIONS AND ACRONYMS

CARE	Corporation of America Relief Everywhere
CIP	International Potato Centre
CYMMT	International Maize and Wheat Centre
DAO	District Agricultural Officer
FAA	Focal Area Approach
FAO	Food and Agriculture Organization
FPR	Farmer Participatory Research
FFS	Farmer Field School
FTC	Farmers Training Centre
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
ITK	Indigenous Technical Knowledge
KARI	Kenya Agricultural Research Institute
MOA	Ministry Of Agriculture
MOALD	Ministry of Agriculture and Rural Development
NAEP	National Agricultural Extension Policy
NASEP	National Agricultural Sector Extension Policy
NEP	National Extension Programme
NFFS	Non Farmer Field School
NGO	Non-governmental Organization
PEAs	Participatory Extension Approaches
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
SM	Soil Management
S&CM	Soil and Crop Management
S&CMFFS	Soil and Crop Management Farmer Field School
S&CMTs	Soil and Crop Management Technologies
SMP	Soil Management Project
TOT	Transfer of Technology
T&V	Training and Visiting

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Agricultural extension is an educational service for advising, training, and informing the farmers concerning practical and scientific matters relating to their farm business and influencing them to use improved techniques in their farming operations which for this purpose, includes livestock and crop production, farm management, conservation and marketing. The main role of agricultural extension agency is to provide advisory services to the farmers related to modern farming technologies. Davis, Nkonya, Kato, Mekonnen and Odendo (2010) noted that extension is responsible to almost one billion small-scale farmers worldwide. It is thus urgent to seek the best ways to support such farmers in terms of information, technology, advice, and empowerment. According to the National Agricultural Sector Extension Policy (NASEP) of the Ministry of Agriculture (MOA), (MOA, 2012), indicate that there have been several extension approaches initiated and used by the Government and other stakeholders not only in Kenya but in many developing countries. The main aim of these extension approaches was to reach millions of smallholder farmers with new agricultural technologies. The main classification of these extension approaches fall into the conventional or the Ministry-based general extension and Participatory Extension Approaches in Kenya.

The Conventional extension approach in Kenya is basically a public sector operated service through the Ministry of Agriculture, Livestock and Fisheries. This conventional extension approach utilizes the ''top down'' model in transfer of technology (TOT), which conforms to the basic assumption that its primary task is to convey superior technologies into the local farming practices or systems. In conventional extension approach, farmers are seen as the recipients of "expert" decision-making, either adopters or rejecters of innovations, but not the originators of either technical knowledge or improved practices. Therefore, in context of this research, the conventional extension approach, which is basically a Ministry operated service, was the current system in existence before the introduction of FFS approach in the project in locations in the North

Rift Valley in Kenya. These conventional approaches included: Model farmer approach, Training and Visiting (T&V), Farming Systems, Farmer Training Centers (F.T.Cs), Catchment approach among others. As an example, the T&V was adopted by the World Bank in the late 1970s and used by a number of developing countries as their National Extension System (Pickering, 1983). The T&V according to Onyango, (1987) was first introduced in Kenya in 1982 as a World Bank pilot project in Kericho and Nandi Districts. Since its initiation the T&V approach dominated the Kenyan extension system for nearly two decades commencing from the year 1982 to 1998 Ministry of Agriculture and Livestock Development (MOALD, 2001). The design of these agricultural extension approaches in the developing countries has been the subject of heated debate about their relevance in addressing farmers' needs and problems.

Guided by these debates of opponents and proponents, extension services have under gone several transformations in the past few decades (Byerlee, 1994). The main transformation worth noting was a shift from the Transfer of Technologies (TOT) model to Training-and-Visit (T&V) system. Under the T&V, extension system was reoriented from a desk-bound bureaucracy with multiple economic and social objectives to a field-based cadre of agents who focus mainly on technology diffusion from contact farmers to the neigbouring farmers (Picciotto & Anderson, 1997). For nearly three decades from late 1970s to late 1990s, international donors, such as the World Bank, promoted T&V as the most cost-efficient extension system. Therefore for a long time according to the National Agricultural Sector Extension Policy (MOA, 2012), the public sector dominated the extension service delivery in the agriculture sector and had good impact as a result of new technologies, a well-funded extension service, an elaborate set of farmer incentives such as ready market, subsidized inputs and credit and relatively good infrastructure.

These conventional approaches have not been successful in delivering the extension services as intended. Roling (2002) termed the conventional extension approaches as ubiquitous technology transfer approach, since it is supply-driven with inadequate participation of the beneficiaries and for all purposes, is largely a public monopoly. It does not give considerations to socio-economic circumstances of the farmer, including his/her knowledge and experience of his/her environment and takes little account of the on-farm and off-farm activities. The main reasons for failures identified through research and several evaluation missions on these conventional extension approaches were due to several reasons. These were enumerated as: less involvement of farmers and seldom farmers were not given a voice as an integrated part of agricultural programmes, adoption the Transfer of Technologies (TOT) model characterized by top-down approach to extension delivery and lack of incentives (Onyango, 1987; Bindlish & Evenson 1993, Anderson & Feder 2006). Other constraints included: lack of relevance and fitness of the technology to the existing farming system, low level of farmers schooling, failure by research and extension to understand and involve clientele in problem definition and solving, weak linkages between extension, research, farmers and other relevant stakeholders (Asiabaka & James, 1999; Rolling, 2002; Davis, 2008). Therefore, finding an extension approach is a special challenge in the African context, as poverty is growing and productivity is declining on the continent (Davis *et al,* 2010). Twenty-four African countries have listed extension as one of the top agricultural priorities for a poverty reduction strategy (Inter Academy Council, 2004). These conventional extension approaches although it was transformed, achieved minimal successes in creating impact in terms of agricultural production and improving the livelihood of small-scale farmers Ministry of Agriculture (MOA, 2007 b).

In Kenya, the National Agricultural Sector Extension Policy (MOA 2012) in contrast to the conventional extension approaches advocates for the use of the participatory extension approaches (PEAs) in problem diagnosis, planning, appraisal, implementation, capacity building of communities, updating of farmers skills and knowledge through training. This policy focuses on a demand driven extension, commercial oriented agriculture with focus on value addition and marketing, strengthening research linkages between farming community and research institutions. The NASEP Vision is to have "Kenyan agricultural extension clientele demanding and accessing appropriate quality extension services from the best providers and attaining higher productivity, increased incomes and improved standard of living by the year 2015". The overall objective of the NASEP is to improve farmer's incomes and poverty alleviation.

The trend worldwide is on the adaptation of Participatory Extension Approaches (PEAs), which include among others: Farmer Participatory Research (FPR), Shifting Focal Area Approach (FAA) and Farmer Field School (FFSs). One very popular extension and education program worldwide is the Farmer Field School (FFS) approach which is in place in at least 78 countries (Braun *et al.* 2006). Started in Indonesia in 1989, FFSs have expanded through many parts of Sub-Saharan Africa. Kenya alone by the year 2003 was the site of more than 1,000 such schools with 30,000 farmer graduates (FAO/KARI/ILRI, 2003). The number has grown rapidly and the number of FFSs which have been implemented is over 2000 with over 60,000 farmers have graduated from these schools (Duveskog, 2013). Many donors, governments, and nongovernmental organizations (NGOs) enthusiastically promote FFSs in Sub-Saharan Africa. As a result of their popularity, there was some discussion as to whether the FFS approach should be scaled up and scaled out and incorporated into mainstream extension practices (Anandajayasekeram, Davis & Workneh, 2007).

From the year 2000 to date, a number of development agencies have since intensified the promotion of FFS as a potentially more effective approach to extend knowledge to smallholder farmers. Studies indicate positive experiences and impact of FFS in various projects reported in Asia and Africa and in particular, the FAO's Community IPM project in Indonesia and Philippines (Rola, Quizon and Jamias, 2002, Van de Fliert *et al,* 2002 & Roling, 2002)**.** Other studies by Erbaugh, Donnermeyer and Amujal (2007) on the impact of FFS participation and non-participation indicates that FFS was an effective approach for increasing both knowledge of Integrated Pest Management (IPM) and the adoption of cowpea specific IPM technologies in Uganda.While Onduru, De Jager, Hiller & Van den Bosch R (2012) in their study, they found out that participation in FFS positively enhanced tea productivity among the smallholders in the study location of Kericho County in Kenya.

1.1.1 The Origin of Farmer Field School Approach

According to Matata *et al.* (2001) the FFS extension methodology was introduced in central Java in Indonesia in 1989, under the assistance of Food and Agriculture Organization (FAO). The Farmer Field School approach according to Quizon, Feder, Murgai (2001) was designed originally as a way of introducing knowledge on Integrated Pest Management (IPM) practices for rice production among smallholder farmers in Asia. The Philippines and Indonesia were the key areas in implementation of this extension effort. The main objective was to control pests in rice fields through the Integrated Pest Management (IPM) program. Rola (2000) noted that FFS approach has been widely tested and adopted in the Philippines and Indonesia as National policy for transmitting knowledge on sustainable agriculture practices to the farmers. The FFS training program utilizes participatory methods which encompasses the principles of non-formal adult education to help farmers develop their analytical skills, inquiry mind, critical thinking and creativity and help them to make better decisions (Verduin, Miller, Greer, 1979; Kenmore, 1997). Pretty (1995), noted that in the FFS approach, the investment is not so much in knowledge, in the formal sense, but rather in the capacity to learn, reflect and know. Training is centered on learning by doing and bringing scientists, extensionists and farmers together to negotiate and learn from each other on a personal level. The focus of FFS is on human resource development for a more sustainable agriculture (Kenmore, 1991; Bentley, 1998; Roling and Van der Fliert, 1994). Therefore, the focus of FFS is not so much on teaching farmers about the new technologies but rather is concerned with developing farmers' own capacity to critically analyse the situation, think for themselves and develop their own solutions.

In the Kenyan context, the Farmer Field School (FFS) approach has gained prominence as an extension approach following its success in training Asian farmers on IPM technologies (Abate & Duveskog, 2003). It was first introduced on a small scale in 1995 by the FAO's Special Program for Food Security (SPFS) to promote maize (*Zea mays*) based IPM in Western Kenya. Since then, over 1500 FFS have been initiated to promote IPM technologies for maize, vegetable; and poultry production, soil fertility management, water harvesting, dairy cattle production, and management of HIV/AIDS (Abate & Duveskog, 2003). The FFS approach has now been embraced by Kenya's Ministry of Agriculture as a promising participatory extension approach and is being considered for incorporation into the National Agricultural and Livestock Extension Program (Sones, Duveskog & Minjauw, 2003; Bunyatta *et al,* 2006). Kenya Agricultural Research

Institute's (KARI's) Soil Management Project (SMP) introduced the FFS extension approach on a pilot basis in 2001 with an aim of validating, disseminating and adoption of the soil and crop management technologies among the small scale farmers in Trans-Nzoia District (Bunyatta *et al.*, 2006). The adaptive research program of KARI adopted the methodology as an up-scaling approach for its promising technologies. By the end of 2003, KARI had initiated over 60 FFSs and trained over 800 farmers (Mureithi, 2003).

1.1.2 Soil Management Project

Participatory rural appraisals (PRAs) conducted in Kitale mandate region indicated that the farmers' perceptions and the scientists' views were in agreement with the constraints limiting agricultural productivity which include: lack of knowledge, low soil fertility, unavailability of suitable animal breeds and lack of water (Rees et al 1996; Soil Management Project (SMP), 1994a; 1996b). In response to the PRA findings, on- farm project for improved soil management namely the Soil Management Project (SMP), which was initiated in 1994 at two Kenya Agricultural Research Institutes (KARI) centres of Kisii and National Agricultural Research Centre (NARC), Kitale. The technical and financial support for the project was through the Rockefeller Foundation (Mureithi & Njue, 1997). The project adopted the PEAs, which included Farmers Participatory Research (FPR), Participatory Rural Appraisal (PRA) and the FFS approach in technology generation, dissemination and utilisation among the small-scale farmers (Mureithi, 2001).

Multi-disciplinary and multi-institutional teams of researchers, extension officers and farmers from five clusters in four districts included: Anin in Keiyo District, Cheptuya in West Pokot District, Chebosta in Uasin Gishu District, Matunda and Weonia in Trans-Nzoia District, were involved in developing the Soil and Crop Management Technologies (S&CMTs) under SMP. At the end of SMP phase one (I), eight promising Soil and Crop Management technologies were identified for scaling-up in the other communities within the mandate region.

The technologies identified for scaling- up through FFS methodology according to SMP, 2001 included:

1. Compost and farmyard manure in combination with half rate of in-organic fertilisers for maize production
2. Compost and farmyard manure in combination with half rate of in-organic fertilisers for vegetables.
3. Use of high quality organic fertilizers in combination with half rate of in-organic fertilizers for Napier grass production.
4. Low cost soil conservation methods which included the establishment of grass strips, contour farming and terracing in a maize plot.
5. Participatory evaluation of suitable maize varieties.
6. Use of indigenous Technical Knowledge (ITK) in identification of plant extracts to control pest in kales, local vegetables and maize.
7. Introduction of legumes (Soya beans, Dolicos lablab and cow peas). other than common beans for soil fertility improvement
8. Compost and farmyard manure in combination with half rate of in-organic fertilisers for quality local vegetable seed production

1.1.3 Scaling up of Soil and Crop Management Technologies by SMP

Kiiya and Muyekho (2000) indicated that (PRA) conducted in Kitale mandate region which include: Trans-Nzoia, Keiyo, Uasin Gishu and West Pokot Districts, identified problems of low crop and livestock yields. The main reasons was due to: lack of inputs, expensive inorganic fertilizers, declining soil fertility due to continuous cropping without nutrient replenishment, high rate of erosion with minimal adoption of soil conservation measures. The SMP developed the eight Soil and Crop Management (S&CM) technologies. These S&CM technologies were disseminated and largely adopted by farmers in the study clusters. In the year 2001, these technologies were up scaled beyond the study clusters to wider farming communities within the Kitale KARI's mandate region of Trans Nzoia, West Pokot, Uasin Gishu and Keiyo Districts using conventional extension and Participatory Extension Approaches in particular the Farmer Participatory Research (FPR) and the FFS approaches. According to studies conducted by Bunyatta *et al.* (2006), Tarus (2003) and Mwagi (2004), to gauge the effectiveness of FFS in dissemination and adoption of S&CMTs, building both women and men farmers' capacity in terms of training and group cohesiveness respectively, they found that FFS participatory extension approach was more effective in respect to the three areas of their study respectively. Therefore the primary focus of this study was to investigate if there was any impact of the already disseminated S&CMTs through FFSs on farmers knowledge, their farming systems and productivity related to maize and income among the small scale farmers in North Rift Valley in Kenya.

1.1.4 Farming System

Farming System (FS) can be defined as a unique and reasonably stable arrangement of farming enterprises managed according to well defined practices in response to the physical, biological, and socio-economic environment and in accordance with the household's goals, preferences, aspirations and resources (Sharner, Philiph, and Schmehl 1982). In the context of this study, Farming System means farm enterprises or practices related to maize, vegetable and fodder production of FFS participants and Non participants after participating in study area of Trans Nzoia and Uasin Gishu of North Rift, Kenya. The farming practice for mos of the farmers was growing crops with minimal or no use of ither organic or inorganic fertilizer for growing their crops.

The farmers in the study locations as per the participatory rural appraisal conducted in Kitale mandate region which include: Trans-Nzoia, Keiyo, Uasin Gishu and West Pokot Districts by SMP according to Kiiya and Muyekho (2000) found out that there were a number of critical problems affecting the farming system and productivity of the farms of the small holder farmers in the study area. The main identified problems were that of low crop and livestock yields. The main reasons was due to: lack of inputs, expensive inorganic fertilizers, declining soil fertility due to continuous cropping without nutrient replenishment, high rate of erosion with minimal adoption of soil conservation measures hence there was declining soil fertility in their farms. This affected the crop yields hence achieving low yields from their farm enterprises which formed their farming system. The farmers in the study locations were mainly practicing subsistence farming system which is characterized by low yields hence low productivity. These were the main reasons for initiation of generation of Soil and crop management technologies to address the identified problems in the farming system of the smallholder farmers in the study locations in the North Rift, Kenya. Socio-economic factors play a key role in any farming system. Farming System according to Sharner, Philiph, and Schmehl (1982) is defined as part of a socio-economic environment and decision making in accordance with the household's goals, preferences, aspirations and resources availability. Hence socio-economic factors formed an integral part of this study.

1.2 Statement of the Problem

The KARI'S SMP developed Soil and Crop Management Technologies (S&CMTs) through Farmer Participatory Research. These S&CMTs have been disseminated through the conventional extension approach and adapted on small scale by farmers within the initial soil management project implementation clusters. Several studies indicate that conventional extension approaches which utilize the Transfer of Technology (TOT) model such as demonstrations, farm visits and contact farmers among others have minimally succeeded in creating a positive impact in terms of improving the farming system and agricultural productivity among the smallholder farmers. FFS due to its successes in dissemination of IPM technologies in Asia, and also being one of the participatory extension approaches was sought by SMP as an alternative to the existing Ministry of agriculture's conventional extension approaches in up scaling the S&CMTs to the small scale farmers in the study districts. In the year 2001 the FFS extension approach was introduced and adapted by the SMP in dissemination of the S&CMTs. Since the introduction of these FFSs, there have been relatively few efforts in Kenya and in particular the SMP FFS clusters to assess and document in a systematic manner the impact of FFS approach on farm system and productivity. Extension and researcher actors often find themselves with many questions unanswered about when, where, and how FFSs should be applied and create impact on farming system and productivity among smallholder farmers. The FFS may be a better dissemination approach in creating greater impact of the S&CMTs on farming system and productivity as compared to the conventional extension approach. Since the introduction and upscaling of these S&CMTs through FFS approach, no study had been undertaken and documented concerning the impact of these technologies on the farming systems and farm productivity among the smallholder farmers in the study locations of the North Rift valley, Kenya. This study therefore was set to investigate and assess the impact of the S&CM technologies disseminated through the FFS approach on the farming systems and productivity among the smallholders in the locations of the study.

1.3 Purpose of the Study

The purpose of the study was to determine the impact of the Soil and Crop Management technologies promoted through Farmer Field School approach on the farming systems and productivity among the smallholder farmers in North Rift region of Kenya. The study examined if there was any difference between the FFS participants and Non FFS in order to determine the impact of the approach.

1.4 Objectives of the study

The following objectives guided the Study:

i. To determine and compare the impact of the Soil and Crop Management technologies promoted through FFSs approach on the knowledge of the FFS participants with those of Non FFS Participants in North Rift of Kenya
ii. To determine the impact of the Soil and Crop Management technologies promoted through FFSs approach on farm system of FFS participants before and after participating in FFSs in North Rift of Kenya
iii. To determine and compare the impact of Soil and Crop management Technologies, promoted through FFS approach on the productivity in terms of farm income related to maize production of the FFS participants before and after participating in FFSs in North Rift of Kenya.
iv. To determine and compare the impact of Soil and Crop Management Technologies promoted through FFS approach on productivity related to level of production per unit area for maize of the FFS participants before and after participation in FFSs with those of non FFS participants in North Rift of Kenya.
v. To determine the influence of selected socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) of the FFS participants and Non FFS participants on the impact of Soil and Crop

Management Technologies promoted through FFS approach in the North Rift, Kenya.

1.5 Hypotheses of the Study

The following null hypotheses were tested at 0.05 alpha levels:

Ho_1 There is no statistically significant difference between FFS participants and Non-FFS participants in knowledge and skill acquired in S&CMTs disseminated through the Farmer Field School approach in North Rift.

Ho_2 There is no statistically significant difference between FFS participants before and after participation in FFSs on their Farming System (farm practices related to maize) as a result of the impact of S&CM technologies disseminated through FFS approach in North Rift.

Ho_3 There is no statistically significant difference between the FFS participants before and after participation in FFSs on their productivity in terms of farm income related to maize production as a result of the impact of S&CM Technologies disseminated through FFS approach in North Rift.

Ho_4 There is no statistically significant difference between FFS participants before and after participation in FFSs with those of Non FFS farmers on their productivity in terms of the level of production per unit area for maize as a result of the impact of S&CMTs promoted through FFS approach in North Rift.

Ho_5 There is no statistically significant influence of selected socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and gender) of the FFS participants and Non FFS participants on the impact of Soil and Crop Management Technologies promoted through FFS approach in the North Rift, Kenya.

1.6 Significance of the Study

The study was designed to assess the impact of the Soil and Crop Management technologies promoted through Farmer Field School approach in relation to the farming systems and productivity among the smallholder farmers in North Rift region of Kenya. The findings of this study will be of great benefit to farmers, extensionist, researchers and policy makers. The small scale farmers will benefit directly by fitting the S&CM technologies into their existing farming system. The extensionist will benefit by having an alternative extension approach to facilitate and enhance the performance in their duties. The researchers will benefit by acquiring new body of knowledge on how to carry out similar studies. The policy makers will benefit from the results of this study by assisting them in decision making and formulation of an informed National agricultural sector extension policy.

1.7 Assumptions of the Study

The study assumed that there was no bias and the respondents gave truthful information. It was also assumed that the respondents understood the questions as asked by the interviewer and that they gave honest, reliable and valid responses. One other assumption is respondents had good recall memory pertaining to the S&CM FFSs implementation, after several years of their initiation hence gave the correct information. The farmers in the study locations irrespective of their resource endowment difference, operated generally under similar conditions of climate, socio-economics, environment and human health within the same agro-ecological zone supporting their farming system.

1.8 Scope of the Study

The study covered the Soil and Crop Management technologies (S&CMTs) developed and disseminated by Soil Management Project-under KARI Kitale in collaboration with Ministry of Agricultures' Extension Officers. These S&CMTs were disseminated using both conventional and FFS extension approaches. Soil and Crop Management Farmer Field Schools (S&CMFFSs) were spread within the North Rift Districts of Trans Nzoia, West Pokot, Uasin Gishu and Keiyo in Kenya. The study purposively selected Trans Nzoia and Uasin Gishu Districts due to their diversity in the coverage of the initiated S&CM FFSs.

1.9 Limitations of the Study

The level of education of farmers might have been a limiting factor in their response to interview questions but it was overcome through interpretation and explanation experienced research assistants and interpreters. The interpreters understood the local language hence ensured that the respondents understood the questioned asked through elaborating them. In absences of these good interpretations, and this might have led to poor quality of responses and low accuracy of the study. The *ex post facto* research design relies on farmers recall memory as opposed to the experimental design which the research has full control of all study variables. Hence probing and clarification of the questions asked assisted in improving the responses given by the respondents.

1.10 Definition of Terms

For the purposes of this study the following operational definition of terms was applied:

Agricultural Productivity refers to the level of yield or quantity of physical output per area or input. In the context of this research is any yield accruing from the output or yield from farm enterprises which used the Soil and crop management technologies.

Agroecosystem according to Reijntes et al (1994) is an ecological system modified by people to produce food and other products desired for human use. In context of this study it is the modification of the ecological system through the incorporation of S&CMTs into the farming system for food production.

Agro-Ecosystem Analysis (AESA) means all environmental and human elements, their interrelationships and its processes e.g. symbiosis, competition and successional changes. In context of this study AESA is where farmer groups come together to conduct field observation and experimentation concerning the S&CMTs they were promoting in their field schools. At these learning sessions farmers exchange their knowledge and experiences thus learning optimally.

Dissemination in context of this research refers to the transfer of S&CM technologies from the source (i.e. research clusters) to the farmers in the research site.

Farmers Field School is a Participatory Extension Approach (PEA) based on adult non-formal education, with emphasis in discovery based learning and hands-on experimentation. It empowers the farmers' groups to understand their environment, identify their problems and seek solutions both internally and externally (Mweri, 2001; MOA, 2007; and Leeuwis, Rolling, Bruin, 1998).

Farmer Field School Effectiveness and its impact refer to the degree and extent to which the FFS activities/program achieve its objectives in creating a positive impact on the farming systems and improving livelihoods of the small-scale farmers in the research

Farmer Field School Participants (FFS – Participants) means small-scale farmers in the research site who voluntarily attended the FFS season-long training from the start to graduation.

Farm practices: is related to the existing farming system components among the FFS and Non FFS farmers and the S&CMTs incorporation after the FFS training.

Farm productivity in the context of this study means the level of change in production in the number of 90 kg bags per unit area of maize and resultant change in farm income of FFS and Non participants as a result of incorporating the S&CMTs into their farming system. Productivity is one of the indicators of impact of S&CMTs on the farm practices.

Farming System (FS) can be defined as a unique and reasonably stable arrangement of farming enterprises managed according to well defined practices in response to the physical, biological, and socio-economic environment and in accordance with the household's goals, preferences, aspirations and resources (Sharner, Philiph, and Schmehl 1982). In the context of this study, FS means farm practices of FFS and non FFS participants related to maize, vegetable and fodder production as a result of incorporation/dissemination of S& CM technologies developed by SMP in the research locations.

Food Security and nutritional status is said to exist when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (MOA, 2007). In the context of this study food security means household food security: Having enough food to eat by all the family members throughout the year.

Household income in the context of this research household income is all income accruing to the household from the farm enterprises or practices and also off farm income such salary or from informal sector.

Impact in the context of this research is operationally defined as achieving a positive change in the farmers' knowledge and skills, level of farm practices related to soil and crop management technologies promoted through FFSs, farm productivity and improved agricultural productivity thus an overall improvement of the farming system hence their improvement in their livelihoods.

Impact in terms of Knowledge is defined in the context of this study as the knowledge and skills acquired through season-long FFS training forums among the FFS participating smallholder farmers.

Productivity is used synonymously to mean the same as agricultural productivity. In the context of this research, it means productivity in terms of the level of production per unit area of S&CMTs promoted through FFSs approach. Also it refers to the household income accruing from the farm enterprises related to the incorporation of S&CMTs.

Promoted through Farmer Field School approach is the use of Farmer Field School as a dissemination approach for the S&CM technologies developed by SMP.

Soil and Crop Management Farmer Field Schools (S&CMFFSs) means all farmers field schools initiated by KARI's Soil Management Project to disseminate soil and crop management technologies among small scale farmers in North rift of Kenya.

Smallholders or Small scale farmers for this study mean farmers with less than (8) hectares of farm as per the economic review of agriculture sector in Kenya (MOA, 2013). This farmers have a limited resource base and hence their need for them to go for low cost agricultural technologies such as the S&CMTs introduced in the the study locations.

Tumbukiza referred to as ''Tumbukiza'' is a Kiswahili word which means to immersed into a trench or simply planting in big hills which are sunken beds. The aim is to conserve moisture and nutrients for improved fertility and water holding capacity. In this study it means an improved method of Napier grass establishment with trench or sunken holes of a spacing of 1.5 meter square.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents literature reviewed to identify the research gaps and to offer in-depth understanding of the concepts, principles and theory of participatory extension approaches in particular the Farmer Field School Approach. The chapter provides mainly reviews related to the agricultural extension services, soil and crop management technologies, FFS background information, review on the impact studies of FFS approach, participatory extension approaches and its application, the farmer's attitude and behaviour. The FFS learning approach and its theories, FFS theoretical framework and finally the description of the conceptual framework which guided the study is presented at the end of this chapter.

2.2 Agricultural Extension Service

Agricultural extension service is a two-way communication and a training process, involving adult learning techniques whose aim is to improve knowledge, change attitude and behaviour. This leads to adoption of new technologies and improved skills for both farmers and extension workers, with a view of increasing and improving farmers' incomes and productivity on a sustainable basis. According to Ray (2011) Agricultural Extension is a science of developing capability of the people for sustainable improvement in their quality of life. The main aim of extension is human resource development.

Agricultural education, extension, and advisory services are a critical means of addressing rural poverty, because such institutions have a mandate to transfer technology, support learning, assist farmers in problem solving, and enable farmers to become more actively embedded in the agricultural knowledge and information system (Christoplos & Kidd 2000, 11). According to Mondal (2014) Agricultural extension is basically an extension education which helps in extending the scientific knowledge of agriculture to the farming community for enhancing agricultural production, processing, marketing including value addition to agricultural produces with the application of latest technology for higher income of the smallholder farmers. Extension is responsible to almost one billion small-scale farmers worldwide. It is thus urgent to seek the best ways to support such farmers in terms of information, technology, advice and empowerment.

According to Reijntjes, Haverkort and Annwaters-Bayer (1994) extension is defined as activities that disseminate research findings and advice to farmers on agricultural practices and improve farmers' analytical capacity and communication so as to help them in their decision-making related to farm management practices.

The above broad definitions refer to services provided by both public and private sectors and it encourages activities related to education, transfer of technology, change of attitudes, human resource development, the gathering and dissemination of information. In the case of the FFS approach as an extension methodology, it fits well to the extension definition in relation to the acquisition of knowledge and its application by the farming communities for improved and sustainable agricultural production.

2.3 Extension Approaches

An "extension approach" according to MOALD (2001) and MOA, 2012) is a style of managing extension. Some of the approaches tried in Kenya includes: The farmer training centres, Integrated Rural Development, Farming Systems, Group, Individual farmers, Training and Visiting (T&V) such as the contact farmer approach with a specific message and the more recent participatory approaches which include the Farmer Participatory Research and Farmer Field School Approach. Training & Visit (T&V) as one specific conventional extension approach among many, did however, have its critics. T&V was very costly to implement due to budgetary constraints from less developed countries. Highly dispersed farmers could never establish frequent contact with extension agents. The farming system was heterogeneous and farmers' needs varied widely and could not be addressed with a single, inflexible technology package as was the T&V designed for a homogeneous farming system (Picciotto & Anderson, 1997; Feder, Willet, Zijp, 2001; Onyango, 2003 and MOA, 2012). These extension approaches are dynamic and may need to be reviewed from time to time.

2.4 Farmer Field School

Farmer Field Schools (FFSs) were conceptualized between the 1970s and 1980s and first implemented in Indonesia in 1989 to deal with the widespread pest outbreaks in rice that threatened the security of Indonesia's basic food supplies (Pontius et al., 2002). The work of some entomologists showed that the massive use of pesticides, promoted by the government to control brown plant hoppers, was the primary cause of the insects' outbreak (Kenmore et al., 1984; Settle et al., 1996). FFSs were therefore organised to educate rice farmers on the ecological relationships underlying IPM, and thereby to help them reduce their reliance on chemical pest controls (Kenmore, 1996). Because agro ecological relationships are inherently place-dependent and time-specific it is ineffective to base decision making on universal dissemination of standard technologies and simple messages. The focus of FFSs was, and still is, on learning through discovery, experimentation and group or community actions.

The FFS approach according to (Khisa, 2014) was developed by an FAO project in South East Asia as a way for small-scale rice farmers to investigate, and learn, for themselves the skills required for, and benefits to be obtained from, adopting on practices in their paddy fields. The term "Farmers' Field School" comes from the Indonesian Sekolah Lampangan meaning simply "field school". The first Field Schools were established in 1989 in Central Java during the pilot phase of the FAO-assisted National IPM Programme. This Programme was prompted by the devastating insecticide-induced outbreaks of brown plant hoppers (Nilaparvata lugens) that are estimated to have in 1986 destroyed 20,000 hectares of rice in Java alone. The Government of Indonesia's response was to launch an emergency training project aimed at providing 120,000 farmers with field training in IPM, focused mainly on recording on reducing the application of the pesticides that were destroying the natural insect predators of the brown plant hopper.

The core principles according to FAO, (2006) and Roling., *et al* (2002) include: Farmer-Centred technology and should be demand driven, Competent Facilitators, Farmer involvement in Agro-Eco System Analysis (AESA) at regular intervals, Regular and frequent FFS follow-up activities such as meetings, field days and workshops and Adult non-formal education which is described as discovery learning, learning by doing, experiential and/ or problem based learning. FFSs thus have social goals beyond mere changes in pest management techniques that seek to promote the empowerment of farmers by building human and social capital (Gallagher, 2000). Farmers are no longer positioned as receivers of already developed technological packages, but are recognized as field experts, who collaborate with the extension staff and researchers to find solutions relevant to the local realities (Moumeni-Halali & Ahmadpour, 2013). FFS programmes emphasize farmers' ownership, partnership and group collaboration.

During the past two decades, FFSs have been held for a large number of crops including cotton, tea, coffee, cacao, pepper, vegetables, small grains and legumes (Pontius et al., 2002). The FFS model has been extended to several other topics such as livestock production, forestry, nutrition and health (HIV prevention) (Tripp et al., 2005). In total, thirty developing countries in the world have implemented the FFS approach on experimental basis (van den Berg, 2004). This sixteen-year history of successes and drawbacks is now looked upon as an invaluable ground for institutional learning, as the recent proliferation of published evaluation studies attests.

The Farmer Field School (FFS) was introduced in FAO's South East Asia IPM program in irrigated rice, after it became apparent that IPM practices which expected farmers to be 'expert' managers of agro-ecosystems could not be transferred by T&V-type of extension services (Matteson, Gallagher, and Kenmore, 1994; Roling and Van de Fliert., 1994). FFS implementation began in East Africa in 1995 with the Food and Agriculture Organization's (FAO's) Special Programme for Food Security. That program ended in 1998. In 1999, FAO's Global Integrated Pest Management Facility 1 started the East African Sub-regional Project for Farmer Field Schools in eight pilot districts in Kenya, Tanzania, and Uganda (Kimani and Mafa n.d.). Supporting the project were the International Fund for Agricultural Development (IFAD), Ministry of Agriculture and Livestock Development (MoALD) and the FAO. The topic was integrated production and pest management (IPPM).

Leeuwis, et al. (1998) described the FFS extension approach as basically comprising of a group of 20-35 farmers with adjacent fields who meet once a week throughout the crop growing season. They carry out systematic comparative studies, observation in the crop fields under the respectively conventional and new technological management. The initial technologies promoted through the FFS methodology were IPM and later soil fertility management. The FFS approach use farmers' group method with emphasis on discovery-based learning and hands-on experimentation. Farmer Field Schools are traditionally an adult education approach which is a method to assist farmers to learn in an informal setting within their own environment. FFSs are described as "schools without walls" where groups of farmers meet weekly with facilitators. They are a participatory method of learning, technology development, and dissemination (FAO 2001) based on adult learning principles such as experiential learning (Davis & Place 2003).

According to Rola and Quizon (2001) the FFS approach in the Philippines, described the FFS as a way of introducing farmers to discovery based learning for dealing with pest and crop management issues in general. Because it educates rather than instructs, the field school is regarded as best suited for introducing knowledge–intensive technologies such as IPM and SM to farmers who have little or no formal schooling. Mweri (2001) described the FFS in the Kenyan context to mean a participatory approach to extension, whereby farmers are given opportunity to make a choice in the methods of production through discovery based learning approach.

Ooi (1998) and Bartlett (1998) found that one of the best criteria for evaluation of technologies under FFS is based on behavioral change in farmers. These farmers' behavioral concerns is to capture mainly how they approach problems in their fields, regardless of whether these are insects, diseases, weeds, water and fertilizers are capable of doing field research. Van de Fliert (1993) indicated that as a result of its manifested success, the FFS has captured the imagination of policymakers, donors and international agencies, who realized that, after the green revolution, they had failed to engage farmers in further agricultural development. FFS encourages farmers to learn through experimentation, building on their own knowledge and practices and blending them with new ideas from other sources such as modern science knowledge among others.

Action oriented decision making and reflection is the key to these PAs as opposed to the conventional extension approaches. FFS approach seems to be the start of a new era in which "small-scale farmers' own creative abilities to optimize their opportunities in their diverse environment in which it can be captured for purposes of ensuring national food security and surplus for export, thus alleviation of poverty (Bunyatta., Mureithi, Onyango and Ngesa., 2006). Van de Fliert *et al* (2002) noted that the concepts of FFS was born in 1989 when the FAO inter-country IPM program designed this innovative model for farmer training on integrated Pest Management (IPM) in rice-based cropping systems in Indonesia. The differences between the conventional agricultural extension and FFS as further noted by Van de Fliert *et al*. (2002) was that FFS model recognized the characteristics of sustainable agricultural development to be people centred, knowledge-intensive and location specific.

Farmer Field School according to Gisha (2014) is a participatory approach to extension, whereby farmers are given opportunity to make a choice in the methods of production through discovery based approach. A Field School is a Group Extension approaches and Methods based on adult education principles. FFS can be described as a "school without walls" that teaches basic agro-ecology and management skills that make farmers experts in their own farms. It is composed of groups of farmers who meet regularly during the course of the crop growing seasons to experiment as a group with new technologies or production options. After the training period, farmers continue to meet and share information, with less contact with extensionists. FFS aims to increase the capacity of groups of farmers to test new technologies in their own fields, assess results and their relevance to their particular circumstances, and interact on a more demand driven basis with the researchers and extensionists to seek for assistance and guidance where they are unable to solve a specific problem amongst themselves. Gisha (2014) summarized the Farmer Field School (FFS) approach as a forum where farmers and trainers debate observations, apply their previous experiences and present new information from outside the community. The results of the FFS training sessions on a regular basis through weekly or fourth nightly meetings are forums where management decisions on what action to take are made. Thus FFS as an extension approach is a dynamic process that is practiced and controlled by the farmers to transform their ideas and observations to create a more scientific understanding of the crop/livestock agro-ecosystem. A field school therefore is a process and not a goal.

In the FFS approach, the facilitators stay with the farmers throughout the cropping cycle or holistic approach to delivery of the technological package rather than the prescriptions and piece meal recommendations common in the conventional extension approaches. It attempts to tackle the specific needs for change towards agricultural sustainability by applying the principles of non-formal education (Van de Fliert, 1993). Non-formal education according to Dilt (2001) is defined as fostering of quality- of- life enhancing learning outside the formal school system. In a recent study on FFS by Moumeni-Halali, and Ahmadpour (2013) described FFS as a form of adult education, which evolved from the concept that farmers learn optimally from field observation and experimentation, a termed referred to as the Agro Ecosystem Analysis (AESA). Therefore, FFS is one of the non-formal education approaches, which embrace the adult education principles. This type of education explicitly recognizes human values as a prerequisite for learning. Experiential learning is a common feature in the FFS training which is linked to living or real problems face by the farming community. It seeks to empower people to actively solve those problems by fostering participation, self- confidence, dialogue, joint decision making and self-determination.

FFS, being a participatory extension methodology with its purpose of sharpening the farmer's knowledge and skills through discovery based learning is in harmony with the current National Agricultural Sector Extension Policy (NASEP) have been reviewed and completed by Ministry of Agriculture (MOA, 2012). The government after investing in the area of agricultural extension with minimal returns earlier, expects with the implementation of the new NASEP will improve in efficiency and effectiveness in agricultural productivity in the country (MOA, 2007). Therefore, FFS is among many Participatory Extension Approaches (PEAs), which are currently under focus for speeding the wheel of agricultural extension through information delivery to the farmers with an aim of achieving sustainable agricultural development.

2.4.1 Farmer field school philosophy

The educational philosophy of the Farmer Field School rests on the foundation of adult non-formal education, and reflects the four elements of the 'experiential learning cycle theory' proposed by Kolb (1984). These include: concrete experience, observation and reflection, generalization and abstract conceptualization; and then active experimentation. Operationally, the FFSs are organized around a season-long series of weekly meetings focusing on biology, agronomic and management issues or practices, where the farmers conduct agro-ecosystem analysis (AESA), identify problems and then design, carryout and interpret simple field experiments using a new technology such as the IPM versus Non-IPM or use of organic and in-organic fertilizers versus the control of non-use of fertilizers on maize production comparisons. In addition, the FFS also include a significant focus on group and individual capacity building. The long-term empowerment goals of FFS seek to enable FFS graduates (Farmers) to continue to expand their knowledge and to help others learn and to organize activities within their communities to institutionalize IPM practices.

2.5 Impact of Farmer Field School

Impact assessment of the FFS approach is critical, and farmers have to be involved in carrying out the activity themselves as the ultimate owners of their development. The abilities of extension staff to facilitate effective impact assessment by and with farmers are as crucial as the array of technical skills and practices that farmers are facilitated to learn. The major goal of the FFS according to Moumeni-Halali and Ahmadpour (2013) is to improve the farmers' analytical skills and decision making, develop their skills in integrated pest management for this case or any other technology and ending the dependency of the farmers in controlling pests. This will apply to any other technology such as the soil and crop management technologies in solving any problem encountered in their farming practices.

Defining FFS impact depends on the stakeholders' views and project objectives. What is seen as impact of IPM depends on a project's objective. What do IPM initiatives attempt to achieve? Is the purpose to reduce insecticide use, to enhance sustainable pest management, or to enhance adaptive crop management? Is it to increase yields, to increase profits, or to improve livelihoods? Although initially, pest resurgence was the problem that triggered the emergence of the IPM-Farmer Field School, the objective has been to enable farmers to become better managers of their fields. Crop health – not pest control – was the central theme in most training. Later still, an objective was added to help farmers become better trainers, organizers and experimenters within their own locally developed programs. The training often went further than increasing farmers' technical capabilities and also helped enhance their educational, social and political capabilities. This raises the question of what should be considered impact: the immediate impacts such as farmer knowledge, decision capabilities, pesticide use or yield, or the indirect developmental impacts such as reduced poisoning, improved biodiversity, community agenda setting or policy change. The IPM Farmer Field School combines an approach to pest management and an approach to farmer education. This combination compounds the difficulties in assessing and measuring impacts. Although impacts in terms of efficiency and effectiveness of pest control are most quoted, assessing the returns to the Farmer Field School as an educational investment is equally important.

So far, most impact studies concentrated on measuring immediate impacts, most notably, the effects on pesticide use and yield. This may have partly been due to difficulties in quantifying and measuring other parameters, due to the lack of methodologies that are accepted by the broader scientific community, or due to the short time-line for many evaluation studies. A number of studies, however, have attempted to capture a broad range of developmental impacts, including changes in the social and political domain.

Davis et al (2010) noted that as FFS implementation is being scaled up in Africa, there are growing concerns and interest among stakeholders and donors regarding the applicability, targeting, cost-effectiveness, and impact of the approach. There have been relatively few efforts to document in a systematic manner the impact of FFSs, and therefore extension actors often find themselves with many questions about when, where, and how FFSs should be applied. In this study therefore, impact study on the FFS implementation has been carried out and the results documented. This study therefore, have achieved at least a step ahead in bringing to light the impact of the FFS approach.

The documentation of the results of this study will go a long way in assisting the policy makers and donors to make informed decisions pertaining to the implementation of the FFS approach in the future, thus avoiding the pitfalls in the investment in agricultural extension service.

Although the FFS approach is a popular method, the new orthodoxy, according to Leeuwis, Röling, and Bruin (1998) in their review FFS approach noted that, much of what is written on FFSs is found only in the grey literature and deals mainly with the methodology or cases of FFS approaches. Thus the long-term impacts of FFSs remain unclear. Some of the evidence on those impacts in peer-reviewed journal articles is conflicting. A brief survey of the impact literature includes the World Bank Asian studies (Feder, Murgai, and Quizon 2004a, 2004b; Rola, Jamias, and Quizon 2002) and additional studies in Cameroon (David 2007), Uganda (Erbaugh, Donnermeyer, and Kibwika 2001), Sri Lanka (Tripp, Wijeratne, and Piyadasa 2005), Bolivia (Bentley et al. 2007), and Peru (Ortiz et al. 2004). Reviews of various projects can be found in van den Berg (2004) and van den Berg and Jiggins (2007). Thus, much is still unknown about the approach and the issues pertinent to extension, such as poverty reduction, sustainability, participation, and financing (Davis, et al, 2010). To explore and document the East African experience, as well as to provide robust evidence for policymakers, donors, farmers, and implementation actors on whether and how FFSs can contribute to agricultural productivity and poverty alleviation, the International Food Policy Research Institute (IFPRI) and the International Fund for Agricultural Development (IFAD) engaged in a rigorous evaluation of FFSs.

Van de Fliert (2002) noted that when aiming at achieving impact in farmers' fields, with impact implying both qualitative improvement of conditions and quantitative coverage; complementary application of the three strategies in partly overlapping and iterative phases and cross-disciplinary collaboration may provide the best results. The impact of FFS can be classified into: educational, social, economic and ecological. Educational impact deals mainly with the learning process in the FFS setting and is measured in terms of knowledge gained among farmer graduates on sustainable agriculture. According to Van de Berg, (2002), they identified three elements of community development as education, generation of knowledge and organization. The process of development often starts with education, which entails the introduction of new principles and tools to aid in self-directed learning. In the context of IPM, initial education was through the FFS approach. Likewise, in the context of this study, knowledge and skills were acquired through season-long FFS training forums. There has been tremendous impact of FFS on farmer education in Asia. Since 1990s, an estimated 2 million farmers were trained through FFS in South and Southern Asia (FAO, 2006).

Van de Berg (2002) noted that the second element of generation of knowledge in the FFS setting occurs through observation, and original research, producing new, locally oriented and relevant information. While the third identified element of organization, occurs through the sharing of knowledge and skills, resulting in new structures, forums, and actions within the community. They concluded that if one of the elements is weak or missing, community development would be sub-optimal. Lack of knowledge generation, will thus obstructs development, whereas lack of organization will lead to individuality. In this study, FFSs served as an avenue of accomplishing the above elements in a holistic manner, therefore the expectations is a positive impact in terms of farmer empowerment in their agricultural development.

The social impact studies are concerned mainly with the farmers' attitudes and behaviour. Rola (1998) on the impact study of FFS in the Philippines found that in the FFS setting the farmers with the help of trained facilitators unravel their behaviour with respect to the use of agrochemical. The influence of farmers' decision making as a result of the FFS training intervention is important. Farmers were made to understand how to grow a healthy crop and at the same time, maintained a healthy environment by less dependence on external chemicals inputs and the use of other pest management measures, which maintain yield at a lower cash cost. Rola (1998) concluded by describing FFS as an extension approach and methodology which aims to promote the manipulation of agro ecosystem to minimize the disturbance of natural elements (capital or assets) in the ecosystem through Integrated Pest Management (IPM).

Pimbert (2002) in his study focusing on social learning for ecology and democracy noted that the emerging issues and challenges in FFS approach. These issues include: social learning for ecology and democracy, institutionalizing social learning and participation and lastly re-governing food system and the commons. Pimbert (2002) summarized his study by noting that, Farmer Field Schools (FFSs) are a form of social learning, negotiation and effective collective action that focuses on society's relationship with nature. In this particular study, the FFSs fitted and played well to the role of educational, social, economic and ecological functions as described in Pimbert paper. Therefore, measurements of learning in the acquisition of knowledge through the disseminated S&CMTs in the research locations can be classified as social learning approach, whereas in the conventional extension training approaches may be classified as an individual learning approach.

Pretty, (1995) and Hade Mouneni-Halali and Ahmadpour, (2013) in their studies on human resource development for sustainable agriculture and impact of FFSs respectively, noted that in the FFS approach or forums, the investment is not so much in knowledge, in the formal sense, but rather in the capacity to learn, reflect and know. Training is centered on learning by doing and bringing scientists, extensionists and farmers together to negotiate and learn from each other on a personal level. They summarised that FFS is basically an adult education, which evolved from the concept that farmers learn optimally from field observation and experimentation. The focus of FFS is on human resource development for a more sustainable agriculture (Kenmore, 1991; Bentley, 1994; Roling and Van der Fliert, 1994). Therefore the concern of FFS is not to teach farmers about the new technologies such as the S&CMTs in the case for this study and knowledge but rather they are concerned with developing farmers' own capacity to critically analyse the situation, think for themselves and develop their own solutions.

Pretty, (1995) found that the IPM-FFS in Asia has produced substantial reductions in insecticide use; while maintaining yields and increasing profits to the small scale farmers. More recently FFS are being considered as an appropriate vehicle for general empowerment of rural actors, in which life-long learning processes and collective actions, implementation of new innovations may lead to improvement in rural livelihoods (Hounkonnou et al., 2004). The FFS approach and adult learning processes are triggering yet another paradigm shift in agricultural knowledge system, building upon two earlier

major shifts: from a commodity to a farming system approach and from linear research-extension-farmer model to dynamic models of technology generation with various degrees of stakeholders' (farmers and others) participation in planning, design and implementation. FFS basically build upon these approaches by embracing the dimension of collective action by farmers' groups and therefore, requires the strengthening of farm-level institutions. In this study such a scenario of increased yields and income could be a possibility, thus this impact study could offer an answer to the questions being sought.
The value of FFS as an effective extension methodology and its impact has elicited interesting discussions across the globe among skeptics and proponents of the approach. For example, debates about the impacts of the FFS approach and the options for large-scale implementation have emerged as a result of the conclusions from a number of impact and evaluation studies. Three studies funded by the World Bank evaluating the impact of IPM-FFS programmes in Philippines and Indonesia concluded that the FFS programmes are fiscally unsustainable because of high costs of substantial up-scaling, no long-term effect of the FFS on pesticides expenditure and yield in rice was observed and no diffusion of knowledge took place to neighbouring farmers (Feder., Murgai & Quizon.., 2004a; .Feder., Murgai & Quizon 2004b; Quizon et al., 2001; Van den Berg, 2004).

Others have criticized these studies in terms of methodology used and the fact that broader impacts such as adult education, social organization, significant dissemination of knowledge-intensive technologies, knowledge acquisition and higher adoption of soil fertility management technologies, behavioral change in farmers towards modern farm practices and farmer empowerment were not taken into consideration (De Jager, 2007; Braun et al., 2006; Bunyatta et al., 2005; NARC, 2004; Bingen, 2003). Critical reviews are made on the 'one-size-fits-all' approach of FFS and call for a more flexible methodology depending on the local situation (Davis, 2006).

Therefore this study is concerned with the already disseminated S&CMTs through both the FFS and conventional extension approach. It is basically a comparative impact study between the Soil and Crop Management-Farmer Field Schools (S&CM-FFSs) participants and the non S&CM-FFSs participants. The SMP project dissemination phase commenced from year 2001.The period since the dissemination from 2001 to-date is over seven years. The expected outcome of the impact study is possibly a positive or negative change resulting in benefits or no benefit accruing to the FFS and Non FFS households.

2.5.1 FFS impact on agricultural productivity of smallholder farmers

There are no studies which have been carried out on the impact of agricultural technologies such as S&CMTs disseminated through FFS training approach in Kenya. However the most recent related FFS study, was conducted by De Jager (2007) on participatory innovation in soil fertility management to improve rural livelihoods in Kenya. De Jager (2007) found out that with the exception of the health situation, a majority of households put through the FFS training observed a positive trend in livelihood aspects such as health, soil fertility, cash flow, reserves for catastrophes, networks and relations, role of women in decision making, access to markets, food security and diversity source of income. Mancini (2006) stated that the potential impact of FFS extends beyond participatory learning and innovation processes in farm management. He recommended that FFS can be considered as a stepping stone to establish or strengthen farmers' organizations, linking farm households to markets and empowering rural people.

As FFS implementation is being scaled up in Africa, there are growing concerns and interest among stakeholders and donors regarding the applicability, targeting, cost-effectiveness, and impact of the approach. There have been relatively few efforts to document in a systematic manner the impact of FFSs, and therefore extension actors often find themselves with many questions about when, where, and how FFSs should be applied. This study was conducted from an informed view after considering both the literature from the proponents and opponents of the FFS approach implementation. Therefore, this study has contributed to the limited studies done worldwide.

In many studies conducted on FFSs globally, indicate that most of the FFS projects implemented have shown evidence of positive impact on rural communities and sustainable agricultural development, hence leading to improved income and livelihoods (Tripp et al., 2004., Mancini, 2006., Praneetvatakul and Waibel, 2006). Van de Fliert (2002) noted that when aiming at achieving impact in farmers' fields, with impact implying both qualitative improvement of farmers' living conditions and quantitative measurements and coverage in terms of farm productivity and improved soil fertility management thus reflected in increased crop yields per unit area. The livelihood outcomes expected from this study will be reflected in: the level of household income, level of knowledge and skills acquired in S&CMTs and its application on their own farming practices and food availability and accessibility as a means of assured household food security.

2.6 Adoption and Practice of Soil and Crop Management Technologies

It was anticipated that after the FFS training each farmer participant or trainee adopted and practice at least one of the S&CM technologies and finally incorporate them into their farming system. Andriano, De Viller and Leslie (2008) on farmer participatory research noted that, promulgation of the FFS acquired knowledge and skills if successfully disseminated and adopted would nurture "Farmer experts" in the local farming community. These farmer experts would then act as an important role models and a local source of advice and encouragement for other farmers within their communities. In context of this study, the impact is expected to be reflected in improved farmers' income, standard of living thus resulting in an overall improvement in their livelihoods.

Pretty (1995) in her study on local groups for sustainable agriculture noted a great difference between the conventional Transfer of Technology (TOT) and the Participatory Technology Development (PTD) and Transfer models. In the TOT model, research is conducted in the research station under controlled conditions. In this research process, farmers have no control over experimentation and technology adoption. These conventional extension approaches apply the linear model of top-down approach. According to Papy (1994) the TOT model is unsuitable for extending innovations (from its theoretical creation to its implementation) to the farming community since it never considered the farmers goals and aspirations nor how well the innovation fit into their farming systems. While in the PTD and Transfer, the farmers are placed at the center of the research process and the research ground is on the farmers' fields or on-farm research. The FFS embraces this PTD model and can help the research institutions become more responsive to the diversified farmers' circumstances, their needs and aspirations within the context of their farming systems.

The FFS farmers' groups encourage their members and other farmers to experiment with alternative farming practices such as the application of S&CMTs on their farms. These FFS training forums facilitate the exchange of information among the FFS participants and the farmers within their neighbourhood about what they have learned. Experiments done at their field school demonstration plots are expected to be replicated on each FFS participant's farm. The reason for group experimentation is to enable thorough discussions and arrive at agreed solutions to solve their problems encountered on-farm.

2.7 Participatory Approaches

Participatory approaches (PA) in the context of this study refer to an umbrella term for a wide range of participatory approaches. These approaches include: Participatory Rural Appraisal (PRA), Participatory Learning and Action (PLA), Participatory Action Research (PAR), Farming System Research, Farmer Participatory Research (FPR) and Farmer Field School (FFS).The common theme to these participatory extension approaches (IIED, 1998) is the full participation of the people (farmers) in the process of learning about their problems, needs and opportunities, and in action required to address them. FFS in particular advocates for developing equal partnership between farmers, researchers and extension agents who can learn from each other and contribute their knowledge and skills in a shared manner.

2.7.1 Technologies generation and transfer

Rogers (2003) defined technological innovation as "an idea, practice, or object perceived as new by an individual or other unit of adoption" (Rogers, 2003, p.36) that can mitigate some of the uncertainty in achieving future outcomes. Five key elements identified by Rogers (2003) pertaining to adoption rate and associated with the innovation itself are: relative advantage, compatibility, complexity, triability, and observability. Relative advantage is a measure of how much improvement an innovation supplies as compared to current practice. Relative advantage can be measured in both social and economic terms. Compatibility measures how compatible an innovation is to existing societal values, experience, and practice. Complexity addresses the degree of difficulty that the adopter has in understanding and using the innovation, while triability assesses the ability of the innovation to be tried at smaller or incremental scales. Observability evaluates the ability of the results of an innovation to be noticed by others within the social system. In the context of this study the soil and crop management technologies from the research phase to the ultimate dissemination through FFSs were subjected to the adoption theory and farmers adopted them at different adoption rates. The technologies which showed high and very high impact on farming system and farm productivity can be said it had fitted well to the identified key elements of adoption enumerated by Rogers (2003) through his studies.

Chambers, Pacey and Thrupp, (1985) described the participatory approach to research and extension in contrast to the conventional approach. Conventional approach is where: the technology is generated in research stations and transferred through extension services to the farmers. They noted that "the participatory research process instead of starting with the knowledge, problems, analysis and priorities of the scientists, it starts with that of farmers and farm families. Instead of research station as the main focus of action, it is now the farm (on-farm). Instead, of the scientist as the central experimenter, it is now the farmer… and other members of the farm family… farmers' participation and priorities are current themes, and reversals too are central. Chambers et al (1992) stated that: together these elements can be described as Farmer- first approach.
The above description fits well to FFS approach which places the farmer at the centre of the research and extension activities. The farmer is the researcher, leader, partner and extensionist in the whole process of farmer participatory research and Extension.

2.7.2 Farmers' attitude and behaviour in the FFS context

Farmer Field School participatory extension approach has proven to be very effective tool for cultivating farmers' learning and empowerment. In particular, they encourage farmers to develop their critical thinking and this leads to greater self-sufficiency in their socio-economic welfare and livelihoods. FFS methodology is flexible and can be integrated with other approaches, and they facilitate the scaling-up of successful technologies and experiences.

Van de Fliert, (2002) identified the gap in understanding farmers' attitude and perception towards FFS training process and its ability in empowering them in terms of knowledge and skills in new agricultural technologies thus improving their livelihoods. This therefore calls for more work to be closer to the farming community, so as to understand them in terms of their behaviour in context of a complex livelihood strategy and the way risk and time preferences bear on their decision-making process. The settlement of communities in Africa presents a complex scenario in that: Rural Africa Landscapes, Kenya included as stated by Van de Fliert (2002) are homes to a wider diversity of farming households, most of them are engaged in non-farm activities as well as agricultural production. This study therefore was also interested in assessing the impact of FFS extension approach on the farming system of the numerous farm families living on the rural landscapes trying to earn a better livelihood through tilling or cultivating it.

2.8 The FFS Learning Approach

The critical theory framework provides a basis for conceptualizing about the FFS approach. As Ingram (1987) pointed out that, all knowledge is related to an emancipating interest: we learn so that we have more control over our world. Learning also frees us from dependence on others. Habermas points out that the first two domains combine through the use of self-reflection to become emancipating (Habermas, 1971). Although the original purpose of learning might come from the technical domain, the learner will not necessarily be able to apply that learning if the practical and empowerment domains have been ignored. What is learned about a technical interest remains to be applied in a social context and this demands interactions (Table 1). The FFS approach unifies these interests and domains in an integrated and integrative educational process. The general purpose of FFS learning associated with the technical domain as indicated in (Table 1), concerns the management decisions that have to be made by a farmer applying the soil and crop management or IPM principles related to agronomic and ecological factors. FFS alumni live in a world where non-FFS participants may not only, understand S&CMTs or IPM but also be openly antagonistic to alumni who would refuse to apply the learnt S&CMTs or pesticides on their farms. Thus learning in the FFS as shown in (Table 1) is connected to the interaction or practical domain must serve several purposes focused on helping other farmers understand and apply IPM or S&CM principles while organizing and collaboratively managing local IPM or S&CM programmes. Empowerment domain concerns the reflection of the developmental process whereby farmers become able to identify factors that inhibit their control over their farming systems and livelihoods.

Table 1
The Learning Domains, Purpose in the FFS approach and its impact on agricultural production

Learning domain	Purpose
Technical	1. FFS graduands manage the use of agricultural inputs based on their analysis of soil fertility, field conditions and knowledge of plant requirements. 2. FFS graduands are able to analyse ecological or soil conditions based on their understanding of soil science and field ecology. 3. FFS graduands design and implement field studies that will help them increase knowledge of ecological and agronomic issues(Conceptualization stage)
Practical	1. FFS graduands are able to effectively collaborate among themselves and with others. 2. FFS graduands facilitate/participate in group processes aimed at identifying, analysing and solving problems. These processes are characterized by communicative action (Dissemination and diffusion theories). 3. FFS graduands facilitate learning among others so that IPM or S&CM becomes the accepted practice to crop (i.e. rice) growing in their village (Adoption theory based on decision making and action leading to practice). 4. FFS graduands organize community action to solve agriculture problems.
Empowerment	1. FFS graduands have developed skills that support critical thinking. They are able to identify and analyse field problems and take action to solve them in common with others. 2. Analytical skills of alumni result in expanded area of action. They are able to organize community action, information networks, village IPM or S&CM programmes (Transformative learning theory).

Table 1 links the critical theory framework presented earlier to the FFS approach. The column "Purposes of the FFS approach" identifies the general purposes addressed by an IPM FFS associated with each domain: technical, practical and empowerment, (Modified: Ingram, (1987).

2.8.1 Technical Learning Domain

The purpose of the FFS approach in connection with this domain focuses on the management and decision-making skills of a farmer concerning agronomic and ecological factors. In order for farmers to be able to grow a healthy crop, emphasis is placed on agronomic management issues such as seed selection, soil preparation, planting in nurseries and transplanting to the field, soil fertility management, water requirements of plants and the timing of irrigation, and cultivation issues. The decisions regarding the use of inputs are connected to plants' physiological development and needs at different stages of their development. The goal is to help farmers optimize their yields by fulfilling the potential inherent in the plants.

Observation of the experimental field regularly concerns learning how to see what is happening in the field where the particular S&CM technology is applied over time. The observation is based on the collection and analysis of field data. In the learning situation, farmers use a formal process (the agro-ecosystem analysis) to gain these observational and analytical skills. Having learned about agronomic and ecological issues, the farmer, during the observation, sees what is happening in the field and is able to make decisions based on knowledge of cause and effect in the field.

Almost all FFS learning activities bear a direct relationship to the technical domain. In particular the agro-ecosystem analysis, special topic activities, the comparative studies and additional field studies conducted during an FFS, all affect the technical skills of a farmer. All of these activities employ the experiential learning cycle: hypothesis formation, data collection, analysis and synthesis, formation of a new hypothesis and testing of the hypothesis. The agro-ecosystem analysis (AESA) in particular helps farmers to master technical issues by experimentation and analysis. Weekly action decisions are taken and implemented as a result of the AESA. Each succeeding week allows the farmers to see and analyze the results of their previous decisions as they conduct additional agro- ecosystem analyses.

During their FFS, farmers master the experimental approaches used in special topic activities and in comparative field studies. They learn to employ the discovery learning cycle. As they gain increased understanding of their agro-ecosystem through experimentation, they increase their control over it. The FFS results not only in participants creating S&CM or an IPM knowledge base, but also in learning how to learn and being enabled to continue to create their own knowledge related to this domain.

2.8.2 Practical Learning Domain

The practical domain in the FFS approach is crucial. The purpose of the practical domain in the FFS is to enhance a range of leadership skills that will essentially help alumni to facilitate learning activities and group problem solving processes as they initiate collaborative activities to institutionalize the technological base or IPM at the village level. Specific leadership skills related to this domain include discussion skills, questioning, analysis, problem solving processes, and communication skills. Every FFS activity includes analysis, presentation and discussion sessions. During these sessions participants practice their analytical skills, learn to present to groups and to handle difficult questions. They coach one another as they make presentations: the shy overcome their reluctance to talk, the imprecise achieve clarity, the weak argument is strengthened, and they gain confidence and voice in articulating their cause of action.

2.8.3 Empowerment Learning Domain

In life, there are factors considered to be larger than life and beyond our control. To successfully take control of these factors, we need to demystify them through critical analysis. Critical analysis is a skill that farmers master as part of the FFS. A principle of empowerment, the possibility of and the need for the progressive replacement of more naive perceptions by more integrative and more discriminating perceptions (Freire, 1968) is a direct result of the critical analysis that takes place within an FFS. The core elements of developing the new innovation systems in smallholder agriculture consist of farmer empowerment, experiential learning and farmer organization.

Knowledge is crucial for people to gain control and power over their situation: the capability of an actor to intervene in a series of events so as to alter their course (Giddens, 1976). Farmer Empowerment is when the farmers assume the authority and gaining control over resources and capabilities to hold accountable and influence the content of public and private agricultural services, such as extension, research, training, information, investment, and marketing. In the conventional extension approach where the main focus is on concentrating on the individual, farmer empowerment needs to address productive, financial, human and organizational assets, knowledge and self-esteem. But for the PEAs such as the FFSs, which embrace the collective or group approach strategy, farmers' organizations are central in providing platform for joint action, enlarge access to ideas, information, expand ties to other network and resources and strengthen the position in input and output markets. The opportunity structures are defined as the formal and informal context in which farmers have to operate and may include aspects such as access to information, inclusion and participation, accountability of officials, local organizational capacity, democratization, response of government structures to peoples demands and aspiration (Narayan, 2005).

2.8.4 Transformative learning theory

In seeking to understand the change in the daily lives of FFS participants, particularly how they make sense of their learning experience, transformative learning theory provides a useful guide in the context of this study. The theory of transformative learning was pioneered by Jack Mezirow, with influences from Paulo Freire and Habermas, is one of the most established theories for making sense of the adult learning process (Taylor 2007). Human beings naturally tend to make meaning of their daily lives and continuously change their perceptions based on new experiences. Transformational Learning (Mezirow 1991, 1997: Cranton 1996) focuses on this process of change in individuals' interpretation of experience. A central concept in this theoretical approach is frame of reference, such as the mental structures by which new experiences are filtered such as values, associations, feelings and conditioned responses. This frame of reference both limits and shapes individuals' perceptions, filtering the experiences they choose to give meaning to and how they construct that meaning. Individuals often tend to reject ideas that do not fit in the existing frame of reference labeling them as inappropriate or not making sense, within their own global understanding. A frame of reference is composed of two dimensions: habits of mind and a point of view. Habits of mind are habitual ways of thinking, feeling, and acting based on the cultural, social, educations, economic, political or psychological standpoints of the learner. Habits of mind become articulated in a specific point of view-the constellation of belief, value judgment, attitude, and feeling that shapes a particular interpretation (Mezirow, 1997). The commonly observed gendered roles and responsibilities among FFS participants for example is an example of habit of mind, where a conditioned response is triggered based on deep held cultural beliefs linked to the societal group that the individual belongs to. In the context of this study for example, domestic activities are viewed as female role while major decisions such as sale of land is viewed as a male role. While points of view are subject to continuing change accessible to awareness and feedback from others, habits of mind are more durable, since they often are tacit and operate outside the awareness of the individual. They reflect collectively held, unintentionally or assimilated shared cultural values and beliefs.

The major elements in transformative learning are critical reflection, i.e. questioning of the habit of mind; rational discourse (dialogue) where reflective judgments and alternate solutions are validated; and practice real life experience (Baumgartner 2012). All these elements are apparent in FFS approach to learning and farmer empowerment. Through the on-farm experiments, farmers are encouraged to try out new practices on their farms such as the implementation of the S&CM technologies. During the FFS sessions farmers conduct Agro System Analysis (AESA) exercises that stimulate objective analysis, through dialogue with peers and their facilitators equally by sharing their experiences rather than in the conventional extension approach, where they make habitually based preconceived assumptions about outcomes. Since the early 1980s, the integrity of transformative learning theory has been established by extensive research (Taylor 2007; Taylor and Cranton 2012). Only recently has research started to explore the application of this theory of transformation in non-western settings (Kollins and Hansman 2005; Merriam and Ntseane 2008; Ntseane 2012). Studies such as Percy's (2005) have noted this limitation in applying Mezirow's conception of transfomative learning to the understanding of change in non-western settings, thus questioning the cultural sensitivity of the theory.

Most African communities view human existence in relation to the existence of others with a worldview that emphasizes belongingness, connectedness, community participation and people centeredness (Ntseane 2012). This is in contradiction to the western setting that emphasise rationality, individual autonomy with a lack of appreciation on relational and collective ways of knowing. Applications of transformative learning therefore need to appreciate the importance of understanding human existence in relation to others (Ntseane 2005; Ntseane 2012). The group based and experiential learning mode of FFS thus fits well in with the traditional African value system that value life experience and wisdom over formal knowledge and communality over autonomous learning. An Afrocentric conception of transformative learning (Asante, 1998; Williams, 2003; Taylor, 2008) has recently emerged (Ntseane and Merriam 2008, Ntseane 2012) that directs attention to this context-dependent nature of significant personal change and the need for awareness of the African value system. There are shortcomings in the transformative learning theory. For example in FFS context, even though transformative learning offers a suitable frame for analysis of FFS participants individual learning experience it does not provide an equally suitable lens for understanding the collective nature of FFS groups, this study therefore hope to generate knowledge around the collectiveness of transformation (Taylor and Cranton 2012). This will respond to the social-individualism exhibited by farmers acting on their own as in the conventional extension as opposed to the FFS approach. Likewise the hope is to further the knowledge by incorporating the transformative learning theory in FFS setting.

In the conventional extension approach which reflects the non FFS farmers or pre-FFS, where farmers were organized by extension field workers into farmers' groups which became moribund or fall back to their original status as before the introduction of a top down extension programme such as the T&V (Onyango, 2003). FFS alumni will possibly reactivate those groups and initiates their own alumni association and register them as commodity Interest Groups (CIGs). Typically, farmers have been organized by others to further their organizers' goals; FFS alumni organize themselves in response to their own needs and they determine their own goals. Empowerment might begin in the FFS, but the FFS is just the first step along a road that is being built by alumni throughout Asia and

Africa to speed up the wheel of agricultural development. The ultimate goal is to give the small scale farmers a voice in charting their own destiny and improving their livelihoods.

2.9 Soil and Crop Management Technologies

The Soil Management Project (SMP) phase (1) was initiated in 1995 in four Districts of Trans Nzoia, Uasin Gishu, Keiyo and West Pokot in the North Rift of Kenya, with funding from the Rockefeller Foundation. The SMP since its inception adopted the farmer participatory approaches for developing, testing and dissemination of soil and crop management practices. The SMP succeeded in developing promising Soil and Crop Management (S&CM) technologies which included: use of organic and inorganic fertilizers at half recommended rate of application for the production of maize, exotic vegetables such as cabbage and kales and indigenous vegetables, fodder establishment by using organic and inorganic mixers at half rate of application on napier grass immersed in a broad hole referred locally as *Tumbukiza* method of establishment, soil conservation methods and alternative legumes. Farmers in the clusters where the SMP technologies were developed adopted these promising technologies to increase their crop and livestock yields. Nasambu and Makini (2000) noted that SMP project had an original objective of developing low cost soil management technologies, which were compatible with the farmers' existing farming system and facilitate the dissemination of feasible interventions to more farmers beyond the research clusters

The Soil Management Project (SMP) of the Kenya Agricultural Research Institute (KARI) was initiated in 1995 with financial and technical support from the Rockefeller Foundation. The two projects adopted the farmer participatory approach for developing and testing soil and crop management practices. Individual farmers, informal farmers' groups and NGOs participated in the projects' activities. Promising technologies were developed and they were ready for wider dissemination. The successes the FFS approach has had in Asia in training farmers on IPM technology made the SMP project to consider introducing FFS as a farmer training and a scaling up approach. The FFS is a participatory extension approach that uses non-formal adult education methods based on experimental learning techniques and participatory training methods. FFS emphasize learning by doing. The learning process takes place in the field and is normally designed to last for a full growing or cropping cycle of the technology. This enables farmers to participate fully in implementation of all components of the technology from planting to harvesting. These learning process during the FFS training sessions accords farmers an opportunity to observe and reflect the merits and demerits of the technologies and thereby make informed decisions on whether to adopt them or not. Mureithi (2001) indicated that a FFS pilot project was launched in January 2001 and covered five KARI-Centers implementing the projects. These were Regional Research Centers at Kisii, Kakamega, Embu and Mtwapa, and the National Agricultural Research Center at Kitale in Trans Nzoia Distict. The pilot project had two phases; the first phase was the training of project staff on the FFS approach, which took one year and the second phase was for the FFS trained project staff to open and run FFSs based on the Soil and Crop Management Technologies that had been identified as promising for up scaling among small scale farmers in the regions.

The S&CMFFS project was implemented in collaboration with FAO- Kenya which had a wide experience in running FFS in western and coastal regions of Kenya. The first activity to herald the introduction of the FFS approach was a three days' workshop to sensitize various stakeholders which included senior KARI and Ministry of Agriculture officials, project staff and members of farmer research committees. The main theme of the workshop was about the introduction of FFS as a project. Mweri and Khisa (2001) noted that this workshop was held in early March 2001 at Kakamega Golf hotel in Kenya. This FFS workshop was attended by over 90 participants among them were the International FFS facilitators from the FAO Global FFS Network. These facilitators included the original initiators of FFS such as from Indonesia, Phillipines and FAO headquarters in Rome.

The second activity according to Mureithi (2001) was training of trainers (ToT) course on FFS approach. The course participants were the project staff and the farmers' leaders of the participatory research committees from the various Districts. The ToT course content was as per the FFS curricula which were designed in two main parts. The first part of the training covered the theory of FFS which took one week and the second part covered the FFS season long field training which took on maximum one cropping or season or otherwise based on the S&CMTs that were being upscaled in the study locations in the various Districts of the North Rift Rift Valley, Kenya. Mureithi (2001) further noted that FAO, Kenya provided two facilitators for this training and were Mr. B.A.M Mweri and Mr. Godrick Khisa. About 60 participants were trained. The first part of the ToT was held from 11 to 17th March 2001 at the Crop Management Research Training (CMRT) Centre of Egerton University. The FFS course according to Mweri and Khisa (2001) covered the introduction of farmer field schools methodology, steps in conducting FFs, organizations and management of FFS and non-formal education methods. The TOT involved field exercises, small group discussions and plenary sessions. After the training at CMRT, the trainees were sent to the Trans Nzoia District at Yuya location where they opened the various S&CMTs farmer field schools. They conducted the season long FFS training under the supervision of the two FAO facilitators until the farmers graduated after the cropping season was over. This study therefore aimed at investigating the impact of these FFSs which had been opened to training farmers on the various promising soil and crop management technologies. These S&CMTs are those which had been developed by SMP in the North Rift valley of Kenya.

2.10 The Theoretical Framework

Farmer Field school approach is based on experiential learning theory by Kolb, (1984). The experiential theoretical model as described by Braun et al. (2006) postulates that the farmer acts as a cognitive agent who pursues and adjust goals and purposes on the basis of iterating through information about changing circumstances which includes environment, knowledge, and perceived options for acting. This theoretical frame is linked to the farmer's decision making process within the context of their farming system. In the context of this study, the assumption that the FFS participants adopted the S&CMTs and incorporated into their farm systems resulting into an increased agricultural production and improved livelihoods.

According to (Duveskog, 2013), Knowledge is considered a transformational process, being continuously created and recreated, not an independent entity to be acquired or transmitted. Van Manen (1977) considers that there are four levels of reflection about acquiring knowledge and transfer which includes: 1) thinking and acting on an everyday basis; 2) more specific reflection on incidents or events; 3) development of an understanding through interpretations; and 4) reflection on the way we reflect. While past lived experiences may seem true to the person they are in fact often incomplete, inadequate, or distorted and not sufficient for experiential learning to occur. A connection must be made between what one has experienced and what one comes to learn.

Experiential learning is the key element in farmer empowerment and is grounded in the concept of adult education (Duveskog, 2013) and focuses on incorporating learners' past experience in the process. Experiential learning is relevant for agricultural extension and FFS, since it provides a means to work with groups to find their own solutions to problems through testing and experimentation of ideas and practices which are closely related to their own everyday farming activities. In reference to van Manen (1977) study about steps in knowledge acquisition, Malinen (2000) further explained that experiential learning, involves ''modification of earlier constructions: re-organization, re-construction, re-defining, re-thinking, re-shaping, re-interpretation and re-formulation, aiming to establish renewed contact with something original''. This is relevant for study of extension methods and approaches aimed at supporting farmers' to explore and reflect over their farming practices such as the S&CM technologies already disseminated through FFS approach. Duveskog (2013) noted that farmers' knowledge is by nature experiential as reflected in their cultivation of their farms which has been shaped over time through experience and generations of trial and error, testing and evaluation.

Experiential learning theory is based upon Kolb's learning cycle (Kolb, 1984) that link theory and practice in a four-stage cycle (Figure 1):

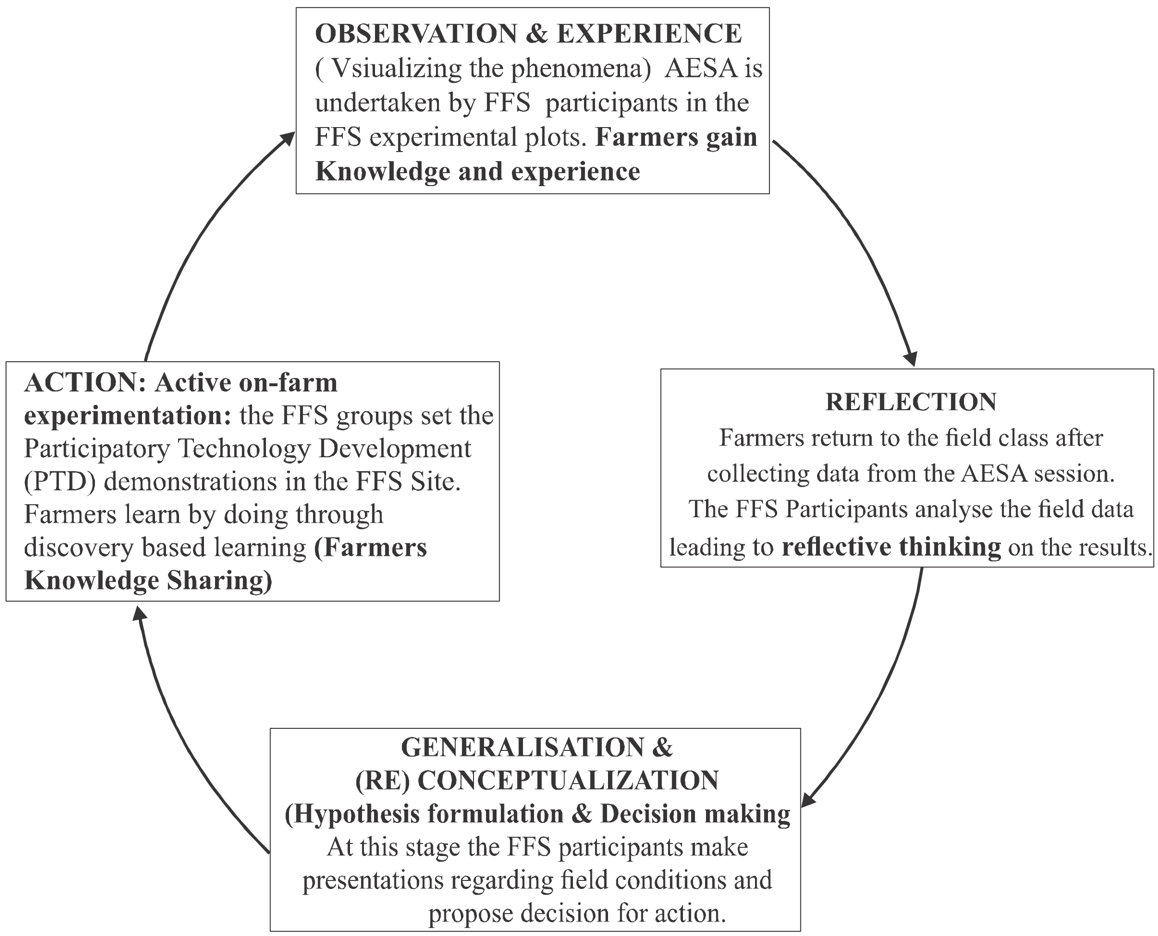

Figure 1. **Experiential Learning Cycle Interfaced with FFS Process Adopted from Kolb's Learning Cycle (Kolb, 1984)**

All FFS learning activities apply the learning cycle. For example, in soil and crop management technologies on the use of organic and inorganic fertilizers for maize production or in the original model of the rice IPM FFS, the agro-ecosystem observation and analysis activity, begins with the observation of a maize experimental plot or in the case of a rice-field agro-ecosystem. Participants collect data in the field where they gain experience through observation of the issue or visualizing the phenomena at hand and return to the meeting place "field classroom" to analyse the data (reflection). The participants make use of their data to prepare a presentation regarding field conditions and propose decisions for actions regarding the rice field, such as whether to apply or not apply fertilizer or insecticides (generalization and conceptualization leading to a hypothesis). The decision is then implemented over the following week (experimentation) and the cycle begins again. In the FFS model, besides experience and actual observation in a formal Agro-Ecosystem Analysis (AESA), the process of reflective thinking is a crucial step in the learning process: making sense out of experiences, evaluation, and share with other learners (Bunyatta, 2006 & De Jager, 2007). This model of learning is different from the learning pursued in the conventional extension system where the individualism in the learning gives rise to the various categories of farmers according to Rogers (1995) as innovators, early adopters down the continuum to the laggards as depicted in the adoption theory.

2.11 Conceptual Framework

The independent variable in the framework is the impact of soil and crop management technologies disseminated through FFS training offered to FFS participants. The FFS participants were expected to be disseminating the soil and crop management technologies to non-FFS participants through informal interactions thus causing an impact on their farming systems and agricultural productivity (improve yield per unit area of target crop maize, vegetables and fodder. Another means of dissemination is through organized field days and demonstrations open to all the farmers within the established field schools. Diffusion of the technologies through the snowball effect was expected. Therefore, the knowledge, adoption and practice of Soil and Crop Management technologies could be enhanced for both the FFS participants and Non FFS participants. The baseline information of the FFS graduates status before joining the field schools was established by asking them about their farming system and productivity levels as compared to after they had graduated from FFS training. This data was used as an indicator as compared to the after FFS training scenario. The overall effect of the independent variables on the dependent variables was reflected in the change in farming practices or enterprises of FFS participants after joining FFSs training as compared than before FFS training and Non FFS participants operationalised in the instrumentation refer (3.6). The moderator variables formulated for the research is the socio-economic factors refer (Figure2).These variables will be studied as intermediate variables influencing the dependent variables.

The dependent variable for the study was impact of Soil and Crop Management Farmer Field Schools (S&CMFFSs) and was operationalised into the FS and productivity variables. The FS variables were the level of change in farm practices, knowledge and skills acquired in S&CMTs and level of household income. The productivity variables included the level of soil and crop management reflected in the level of production per unit area for maize. The independent variables were the S&CM FFS and conventional extension approaches used in farmer training and dissemination of S&CMTs. Moderator variables were socio-economic factors of the respondents.

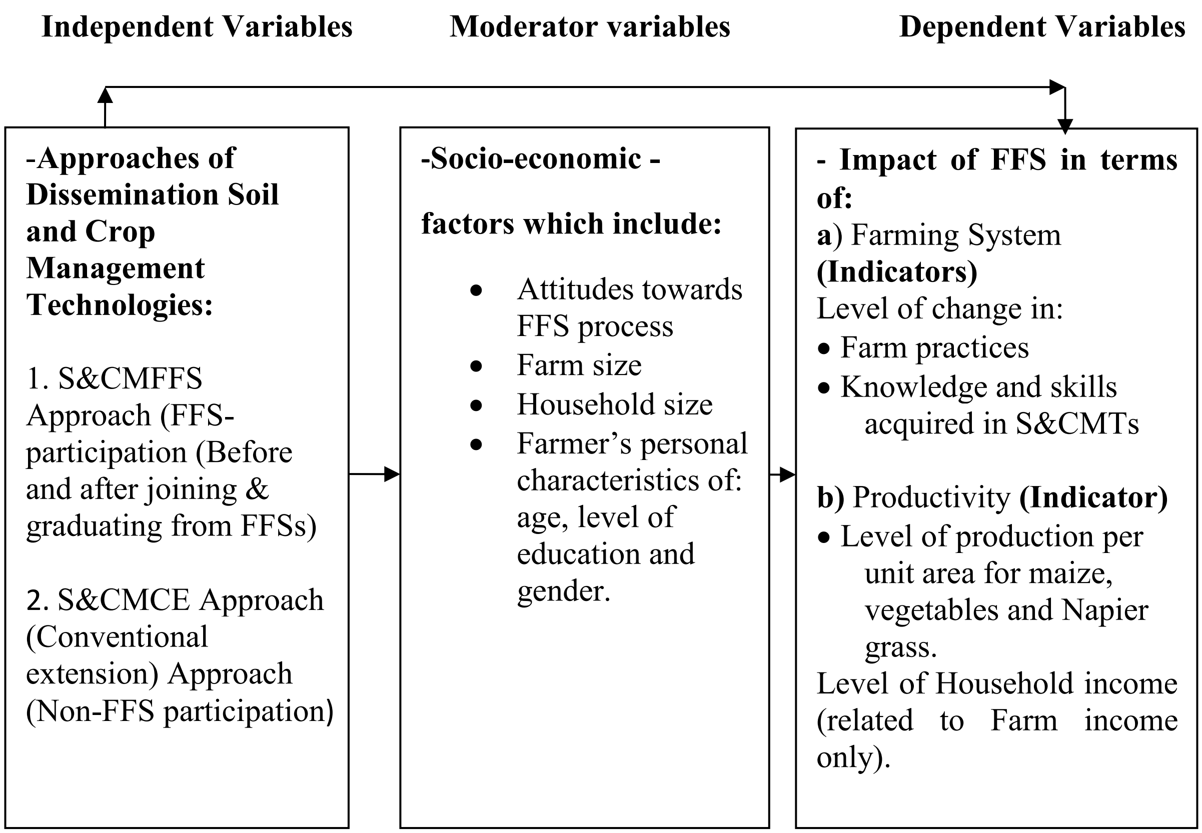

***Figure 2.* Conceptual Framework of the impact of the soil and management technology model showing: the dependent, independent and moderator variables**

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter covers the research methodology employed to accomplish the main objectives of the study. The main sections include: the research design, description of the study area, the FFS enrollment and technologies disseminated in these field schools, sample frame and sampling procedures, instrumentation, data analysis and analysis summary table.

3.2 Research Design

The study employed a survey research method with an *ex-post facto* research design. This design according to Kathuri and Pals, (1993) refers to examining the effect of "a naturalistically occurring treatment after the treatment has occurred". The study examined what had been done in the research sites as it pertains to implementation of FFS in the years 2001 and 2002. A survey research is concerned with making accurate assessment of inferences and relationship about phenomenon, events and issues (Edwards, 2006). This study was designed to assess, analyse, describe and determine the impact of S&CMTs - FFS on the farming system and farm productivity of the small scale farmers in Trans-Nzoia and Uasin Gishu Districts of North Rift, Kenya.

3.3 Location of the Study

The study areas were Yuya, Birbiret and Motosiet locations of Kaplamai Division and Matunda location of Kimilili Division-Trans-Nzoia District and Kipangui Location of Siwa Division- Uasin Gishu District. The reason for selecting these research locations was because FFSs had been initiated by SMP. The promising S&CM technologies had been upscaled through these FFSs. In the first batch, eight farmer field schools were established and fourteen field schools in the second batch. The map of the study area is indicated in Figure 3.

Table 2

FFS Enrolment per School and technology disseminated in the 1st batch -Yuya location, Kitale-Trans Nzoia District

S&CM Technology	School Name	Members				
		M	F	Total	Before	After
1. Forage production and utilization	Khuyatana	13	18	31	30	30
2. Organic/inorganic fertilizers for maize	Bikholwa	5	16	21	18	18
3. Introduction of legumes other than beans	Bulala	18	10	28	21	21
4. Organic/organic fertilizer for vegetable	Busime	9	13	22	17	17
5. Introduction of suitable maize varieties	Twende	7	11	18	11	11
6. Quality seed production	Upendo	6	24	30	16	16
7. Low cost soil conservation methods	Mteremko	11	9	20	11	11
8. Indigenous technical knowledge for Pest control	Mutua	8	14	22	16	**16**
Totals		77	115	192	140	140

*S*ource: Soil Management Project (2001)

Table 3

FFS enrolment per School, Graduands and technology disseminated in the 2nd batch FFSs in Trans Nzoia District and Uasin Gishu District, Kenya

Soil &Crop Management Technology	School name	Members			FFS graduands	
		M	F	Total	Before	After
1. Forage production and utilization	Mwangaza	13	18	31	26	26
2. Use of organic/inorganic fertilizers for maize	Mawazo	14	16	28	18	18
3. Variety selection in maize (H-614, 625,626,512 511).	U-Hututu	15	20	35	24	24
4. Organic/inorganic fertilizer for vegetable production	Weonia	19	24	43	36	36
5.Introduction of maize varieties & org/inorg for maize	Amua	18	11	29	16	16
6. Forage production, utilization, and Low cost soil conservation methods.	Motosiet-Mwangaza	8	22	40	32	32
7. Introduction of legumes other than beans	Samiko	16	14	30	26	26
8. Organic/inorganic fertilizer for vegetable production	Jiokoe	11	15	26	18	18
9. Use of organic/inorganic fertilizers for maize	U-kapsara	9	16	25	22	22
10. Use of organic/inorganic fertilizers for maize	Miti-Moja	13	17	30	21	21
11. Organic/inorganic fertilizers for maize	Matekesi	21	24	45	40	40
12. Introduction of legumes other than beans	Kamito	23	21	44	39	39
13. Forage production /utilization and organic/inorganic fertilizers for maize	Kokwet	11	14	23	24	24
14. Use of organic/inorganic fertilizers for maize	Taiit	12	15	26	19	19
Totals		**220**	**247**		**361**	**361**

Source: Soil Management Project (2004)

3.4 Target Population

The target population for this study consisted of the FFS participants and Non FFS Participants. The FFS participants are those farmers who enrolled in the FFSs and underwent season-long FFS training on the S&CM technologies until they graduated. The FFSs population shown in Table 4 as 501 participants distributed in 22 FFSs.

Table 4

FFS population and sample per School

Name of FFS	Population (FFS Graduands)	
	Before	After
1) Khuyetana	30	30
2) Bikholwa	18	18
3) Bulala	21	21
4) Busime	17	17
5) Twende mbele	11	11
6) Upendo	16	16
7) Mteremko	11	11
8) Mutua	16	16
9) Mwangaza*	26	26
10) Mawazo	18	18
11) Umoja-Hututu	24	24
12) Weonia	36	36
13) Kwanuzu	16	16
14) Motosiet-Mwangaza	32	32
15) Samiko	26	26
16) Jiokoe	18	18
17) Umoja-Kapsara	22	22
18) Miti Moja	21	21
19) Matekesi	40	40
20) Kamito	19	19
21) Kokwet	24	24
22) Taiit	39	39
Total	501	501

Source: SMP, 2001

Key: List of FFSs starting from 9) Mwangaza* 22) Taiit were the second phase FFSs.

While the non-FFS participants are those farmers who were exposed to the S&CM technologies using the conventional training methodologies. The Non FFS participants are the farmers in the same locations of study who never enroll and attended the FFS training sessions.The research unit composed of the household heads or any other member of the household who participated in the FFS training. A comprehensive list of all small-scale farmers in the locations where the FFSs were established was obtained from the District Agricultural Officers of Trans- Nzoia and Uasin Gishu Districts. The list of the FFS participants was obtained from the co-coordinator FFS-KARI- Kitale. The List of FFS was then used to segregate the FFS participants from Non FFS participants.

3.5 Sampling Procedures and Sample Size

This section describes the sampling procedures employed to obtain both the participants and nonparticipants sample sizes used for the study. It also shows the calculation formula used to arrive at the sample size used for the study.

3.5.1 Sampling of FFS Participants

The Yuya FFS site and the other locations in the two Districts were purposively selected due to being the pilot area and up scaling areas for FFS under SMP respectively. Proportionate stratified random sampling was used to determine the sample of FFS participants. The stratification was by the different Farmer Field Schools. The FFS Participants was stratified into their FFSs and simple random sampling method through the use of table of random numbers, was applied in selecting the respondents. The total Population of the FFS Participants was 501 and was distributed into twenty two FFSs as shown in Table 4.

The sample of FFS respondents was 180 and proportion was worked out using the following formula derived from Tuchman (1978):

$$\frac{Ps}{\Sigma Ns} \times n = ns$$

Where: Ps = Population in the stratum

ΣNs = Total population of FFS Participants.

n= Required Sample

ns= Sample size per FFS

Example Khuyetana- is $\frac{30}{501} \times 180 = 11$

NB: Purposively 14 were chosen for the above school.

Bikholwa FFS $\frac{18}{501} \times 180 = 7$ as shown in table 2. The same procedure of calculation was followed

for other schools to arrive at the sample as indicated in Table 4.

Table 5

FFS population and sample per School

Name of FFS	**Population (FFS Graduands)**		**Sample**	
	Before	After	Before	After
1) Khuyetana	30	30	11	11
2) Bikholwa	18	18	7	7
3) Bulala	21	21	8	8
4) Busime	17	17	6	6
5) Twende mbele	11	11	4	4
6) Upendo	16	16	5	5
7) Mteremko	11	11	4	4
8) Mutua	16	16	5	5
9) Mwangaza*	26	26	9	9
10) Mawazo	18	18	7	7
11) Umoja-Hututu	24	24	9	9
12) Weonia	36	36	13	13
13) Kwanuzu	16	16	5	5
14) Motosiet-Mwangaza	32	32	12	12
15) Samiko	26	26	9	9
16) Jiokoe	18	18	7	7
17) Umoja-Kapsara	22	22	8	8
18) Miti Moja	21	21	8	8
19) Matekesi	40	40	14	14
20) Kamito	19	19	7	7
21) Kokwet	24	24	9	9
22) Taiit	39	39	13	13
Total	501	501	180	180

Source: SMP, 2001

N/B- Number one to eight indicate 1st generation or batch of FFS of which **140** farmers graduated , while the 2nd batch of FFSs Starting from Mwangaza FFS * 9 down to No 22 of which **361** farmers graduated making a total of **501** as indicated above.

The first 8 eight FFSs as shown in Table 5 indicate the 1st batch of FFSs which were first started by SMP in Yuya location in Trans Nzoia District in year 2001. In the first batch of FFSs a total of 140 farmers graduated. While the 2nd batch of FFSs Starting from Mwangaza FFS * 9 down to No 22 as shown in Table 5 by adding them it add up to **361** farmers who graduated from this FFSs. The 1st batch graduads were 140 + 361 for 2nf batch graduand making a total of **501** as indicated as shown in Table 5.

3.5.2 Sampling of non-FFS participants

The total population in the research locations is 6,240 households out of which 501 were the households who participated in the FFS training (SMP, 2001). The remaining 5739 households formed the non-FFS participants. The non- participants households of 5739 were subjected to stratified simple random sampling technique. Farmers were stratified according to locations and finally villages and then simple random sampling was employed to select the non-FFS respondents through the use of table of random numbers. This group of farmers formed the control group which was compared with FFS participants in terms of the variables designed for the study.

3.5.3 Sample size

Using the formula recommended by Kathuri and Pals, (1993) quoted from Krejcie and Morgan (1970) the sample size was calculated as follows:

Formula: - $$n = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

Where:

n = required sample size.

N = the given population size (501 – trained FFS farmers and 5,739 Non-FFS farmers).

P = Population proportion assumed to be 0.5.

d = $\pm$ 1.96 σP.

X^2 = table value of chi-square for one degree of freedom relative to desired level of confidence, which is 3.84 for the .95 confidence level/represented by entries in the table.

From application of the formula the sample size is as reflected in Table 6.

Table 6

Calculated and Chosen sample per category

Category	N	Calculated Sample n	Chosen sample n	Remarks
FFS-trained Farmers	501	240	180	Reduced by 25%
Non-FFS farmers	5,739	380	180	For comparison
Total	**6,240**	**600**	**360**	**360** respondents.

Source: Kathuri and Pals, (1993).

Three hundred and sixty (360) farmers were chosen as the sample size instead of 600 farmers which is statistically justified since Kathuri and Pal (1993) recommends a minimum sample size of one hundred (100) for a survey research.

3.6 Data Collection Instruments and Instrumentation

For this study, two instruments were used for data collection. The two instruments included an interview schedule and a test.

3.6.1 Interview schedule

The interview schedules were administered through face to face interviews by the researcher to the FFS and non-FFS participants. The interview schedule was designed to capture the impacts of the S&CM technologies on the farming systems and productivity among the respondents. An interview schedule according to Mugenda and Mugenda (2003) is a set of questions that the interviewer asks when interviewing. The Farming System variable was operationalised into several variables to include: level of change in: farm practices, knowledge and skills acquired in S&CMTs. While the productivity variable was operationalized into several variables to include: level of production per unit area for maize, vegetables and Napier grass under Tumbukiza production method compared to conventional production and Level of household income (related to farm income only)

3.6.2 Test on Common Agricultural Knowledge

A test was designed based on common agricultural knowledge on Soil & Crop Management Technologies Promoted through FFSs. The test was administered to the FFS and non-FFS participants to gauge their knowledge acquired in S&CM technologies disseminated through the farmer field schools. The questions were designed as statements based on the S&CMTs and the general knowledge on basic farming practices.

The test was administered orally by the researcher who read out each statement to the respondent. Their answers and responses were recorded in the test instrument.

3.6.3 Validity

Validity according to Mugenda and Mugenda (2003) is the accuracy and meaningfulness of inferences, which are based on the research results. The two instruments were given to the Egerton University academic staffs who are experts in agriculture education and extension to check for validity. They read through and determined the content and face validity. This was to ensure that the instruments measure what was intended to measure.

3.6.4 Reliability

The test and the interview schedule were pilot-tested with 15 FFS farmers and 15 non FFS farmers making a total of 30 farmers in Kibagenge and Labkeiyet FFS Keiyo District. This site was part of the first batch of the FFSs started in the National Agriculture Research Centre (NARC)-Kitale. The site was chosen since it was part of the SMP FFS – Pilot project and work under the same national co-ordinator. The farming system of Keiyo research site is almost similar to the Uasin Gishu and Trans Nzoia- Kitale sites.

The results of the pilot test were subjected to a reliability test. The aim of the test was to measure the degree to which a research instrument yields consistent results after repeated trials (Mugenda & Mugenda 2003). Cronbach's alpha coefficient was used to estimate the reliability of the questionnaire and the test instruments. Bryman and Cramer (1997) and Mugenda and Mugenda (2003), indicated that the minimum threshold level of acceptance of an instrument for social research is set at 0.7 coefficient alpha. The reliability coefficient was 0.7383 for the productivity and 0.7497 for farming system ie level of change in farm practices questionnaires, while the reliability coefficient was 0.7329 for the common knowledge test instrument.

The reliability of the instrument was improved through extending the length of items and removing ambiguous questions. The instrument was checked for validity through discussion with peers and faculty experts for their input. This ensured that the included items measured what they were intended to measure in the research objectives.

3.7 Data Collection Procedures

The research commenced after being given an introductory letter from the graduate School of Egerton University in order to seek a research permit from the National Council of Science and Technology. The research permit was obtained from the council on 9th August 2012 and was valid upto 1st Februry 2013 (refer to apppedix 11). Three research assistants were identified in consultation with the District Agricultural Officers (DAO). These research assistants assisted the researcher in data collection. They were first trained on how to conduct the research for three days. The content of this training was on the important of these research and the main objectives. The research assistance were taken through the instruments of data collection. During the third day of training, the researcher and the research assistant made a field visit to yuya research site to carry out the first data collection exercise at yuya cluster. This was done as a team for two days with closer supervision from the researcher. After being satisfied that the research assistants were competent enough to conduct interview, data collection commenced in October 2012 to December 2012 for a period of three months.

Before the start of the field data collection, appointments were made with the respective District Agricultural Officers (DAO) to brief them about my study. Then permission was sought from the DAOs to engage their field officers as guides with in identifying and locating the respective households where the respondents were sampled. Interview schedules were pre-arranged through making appointments for the interviews to take place at the homes of the randomly chosen respondents. The interviews were carried out through face-to-face contact between the interviewer who was either the researcher or his appointed trained research assistants and the respondents. The researcher administered the test by reading out every statement to the respondent and entering the responses in the check list as was stated by the respondents. The data collection activity was under a close supervision by the researcher.

3.8 Data Analysis

In analysis, both descriptive and inferential statistics was employed. The null hypotheses were tested at 0.05 level of significance. Collected data was coded and analyzed by the Statistical Package for Social Scientists (SPSS) for windows computer program. Descriptive data of all independent variables were analyzed and presented as percentages, means, frequencies and standard deviation. While for inferential statistic t-test and one way analysis of Variance (ANOVA) were used by the researcher to compare the sample means. The objective of the two tests was to determine whether there was any statistically significance difference between means scores of the two groups (FFS-participants and non-participants). When the value of t-calculated was greater than the t-tabulated (1.96) then null hypothesis was rejected at 0.05 level of significance. Multiple regressions was used to determine whether the independent and moderate variables identified together predicted the formulated dependent variables.The summary of the data analysis is presented in (Table 7).

Table 7

Summary of Statistical Tests used in Data Analysis for the Study

HYPOTHESIS	INDEPENDENT VARIABLE	DEPENDENT VARIABLE	METHOD OF ANALYSIS
Ho_1 – There is no statistically significant difference between FFS participants and Non-FFS participants in knowledge and skill acquired in S&CMTs disseminated through the Farmer Field School approach in North Rift Districts	Dissemination of Soil Management technologies through FFS/Extension training	Level of knowledge and skills acquired in S&CMTs of the FFS (before and after joining FFS) and NFFS participants	Descriptive statistics for means, percentages, SD Inferential statistics-Independent Samples t-test
Ho_2-There is no statistically significant difference between FFS participants before and after participation in FFSs on their Farming System (farm practices/enterprises) as a result of the impact of S&CM	Dissemination of Soil Management technologies through FFS/Extension training	Farming System outcomes include: Level of change in:-Farm practices in: (maize,	Inferential statistics paired t-test

Technologies disseminated through FFS approach in North Rift Districts		vegetables and fodders) with respect to S&CMFFS interventions	
Ho$_3$– There is no statistically ;significant difference between the FFS participants before and after participation in FFSs on their productivity in terms of farm income related to maize, vegetables and fodder production as a result of the impact of S&CMTs disseminated through FFS approach in North Rift,Kenya	Dissemination of Soil Management technologies through FFS/Extension training approaches	Income outcome: change in: a) Level of Household income	Descriptive statistics for Percentages, frequency, Means, and SD Inferential Statistics: Paired t- test.
Ho$_4$ – There is no statistically significant difference between FFS participants before and after participation in FFSs and Non FFS farmers on their productivity in terms of the Level of production per unit area for maize, vegetables and fodder as a result of the impact of S&CMTs disseminated through FFS approach in North Rift	Dissemination of Soil &crop Management technologies through FFS/Extension training	Impact of FFS in terms of: Farming System: Level of change in farm productivity in terms of: Maize, vegetables& fodder yields of FFS (before and after participants joining FFS) and NFFS.	Descriptive statistics i.e.(use of Percentages, SD, Frequencies) Inferential Statistics: Independent Samples t- test and One way ANOVA
Ho$_5$–There is no statistically significant influence of selected socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) on the impact of Soil and Crop Management Technologies disseminated through FFS approach in the North Rift, Kenya.	Soil & Crop Management-FFS training and its dissemination among the FFS and Non FFS Participants	Socio-economic factors Farmers', attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education &sex	Descriptive statistics i.e.(use of Percentages, SD, Frequencies) Inferential Statistics Multiple regression analysis.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the findings of the study based on the interview schedule and a standardized test instruments for data collection are presented in relation to objectives and hypotheses of the study. The first section covers the descriptive statistics which basically are the socio-economic characteristics of the respondents, The second part considers the results and discussion based on the inferential statistical analysis of the objectives and test of the hypotheses as stated in chapter one.

4.2 Descriptive Statistics

This section presents the descriptive parameters of the respondents' socio-economic characteristics**.** The socio-economic characteristics of interest for this study were: sex, age, and relationship of respondent to the head of household, level of formal education including the farm size, household income and household size. The descriptive analysis is presented in the form of tables showing frequencies and percentages of the respective parameters.

4.2.1 Gender of the respondents

Sex of the respondents was important in this study because it relates to enrolment in agricultural activities such as FFS season long training. Sex is also important in decision making processes pertaining to agricultural activities at household level. The results of this characteristic are presented in Table 8.

Table 8

Distribution of Farmers by Their Gender in Study locations of The North Rift

Gender of Respondent	Frequency FFS	NFFS	Both	Percent FFS	NFFS	Both
Male	96	100	196	53.3	55.6	54.4
Female	84	80	164	46.7	44.4	45.6
Total	**180**	**180**	**360**	**100**	**100**	**100.0**

Key: FFS –Farmer Field School Participant. NFFS– Non Farmer Field School Participant, Both – FFS and NFFS combined, to reflect the overall results

Data in Table 8 reveals that less than half (46.7 percent) of FFS respondents were female and 53.3 percent males while for the non-FFS respondents (44.4 percent) were female and 55.6 percent male. The farmers' enrollment into most agricultural programmes normally follows the same trend where more male farmers undergo agricultural training such as in the FFS programme (Duveskog, 2013). The FFS programme indicated that 60 percent of the farmers were female (SMP, 2001). Therefore, the sampled farmers for this study did not follow the same trend as it was in the initial recruitment into Soil Management Project Farmer Field Schools (SMP FFSs). The trend was in conformity to the normal gender studies where in most rural development programmes open to men and women, men dominates (Tarus, 2003). In this study the majority of the respondents for both FFS and Non FFS combined were male (54.4 percent) as compared with females who were 45.6 percent (Table 7). This was expected since in most cases males are decision makers at farm level in the traditional African set up.

4.2.2 Relationship to the head of the household

The study was designed to target respondent who were the heads of the households. This was important because, in normal situations the household head is in charge of decision making (Davis. et.al. 2010). The results of the study, in relation to the head of household are presented in Table 9.

Table 9

Relationship to household head

Respondent	Frequency	Percent
Self	226	62.8
Wife	132	36.6
Sons& daughters	2	0.6
Others	0	0.0
Total	**360**	**100.0**

N=360

The interviewed respondents were mostly the head of the household referred to as self in the table indicating 62.8 percent while 36.6 percent were the wives to the household head. In very few cases 0.6 percent of the persons interviewed were either the sons or daughters representing the household head. From the results it can be concluded that, the researcher interviewed the targeted respondents (household heads).

4.2.3 Age of respondents

Age of the farmers is an important parameter to study due to several reasons. Age according to this study may influence decision making at household level, especially in matters concerning the adoption, practice and the impact of soil and crop management technologies disseminated through FFS approach. Several studies (Epeju, 2003, Davis et al. 2009; Duveskog, 2013) have shown that in normal situation, older farmers are less inclined to accepting new agricultural technologies especially where there is high labour demands is involved as compared to younger farmers. Also highest adoption, practice and realization of greater impact of agricultural technologies are found within the middle aged farmers (Davis et al. 2009). Epeju, 2003 in his study found out that farmers in the 41-80 year age group category (43%) of the total respondents grew sweet potatoes because most persons in this age range controlled the factors of production and had large families. From the previous studies as reported, age of the respondent is important in decision making pertaining to the engagement in the farming activities such as the enrollment and attendance of FFS training and the implementation of the soil and crop management technologies on their farms. This study therefore was conducted to find out the ages of both the FFS and non FFS respondents in relation to the implementation of S&CM technologies promoted through Farmer Field Schools in the research locations. The results related to age of the respondents are presented in Table 10.

Table 10

Distribution of Farmers by Age

Age Category	**Frequency**		**Percent**	
	FFS	**NFFS**	**FFS**	**NFFS**
20 – 30	6	6	3.3	3.3
31 – 40	32	42	17.8	23.3
41 – 50	59	55	32.7	30.6
51 – 60	46	54	25.6	30.0
61 – 70	32	21	17.8	11.7
71 – 80	5	2	2.8	1.1
Total	**180**	**180**	**100.0**	**100.0**

Key: FFS – graduates: n = 180 NFFS- graduates: n=180 N= 360

The results in Table 10 indicate that 32.7 percent of FFS respondents were of ages between 41-50 years, while among the Non-Farmer Field School (NFFS) respondents almost the same number 30.6 percent were in the same age category. The mean age of both FFS and NFFS is 44.5 years. This average age for farmers in the study area concurred with the findings of Epeju, (2003) who conducted studies on perceptions of growing sweet potatoes in Teso in Uganda. The findings by Wasula (2000) indicated that, age of the farmers influence the level of adoption and practice of agro-forestry technologies. Therefore it was expected that age of the farmers could influence the level of practice hence impact of S&CM technologies among the smallholder farmers in the research locations. The minimum and maximum ages for FFS respondents were: 20 years and 77 years while the non-FFS respondents were 21 years and 80 years respectively.

The combined age categories with most of the respondents as shown in Table 10 were 31- 40 years (17.8 percent), 41-50 years (32.7 percent) and 51-60 years (25.6 percent) who total to 76.1 percent of the FFS while non FFS participants same age categories combined were 83.9 percent of respondents. Both the FFS and Non FFS respondents with age category of 20- 30 years were 3.3 percent while those of 71-80 years were 2.8 and 1.1

percent for FFS and FFS respectively. The age distribution reflects an aging farmer population trend. These was in consistent with the results in the Agriculture Sector Development Strategy (ASDS) of the Ministry of Agriculture (MOA, 2012) which shows that in Kenya the younger generation have less interests in farming, while about a half of farmers are above 50 years.

4.2.4 Household Size

The numbers of persons in a household play an important role in providing labour for farm activities. This parameter was of importance to the study because the technologies that were being promoted under the FFS programme required labour for practice. In this study, the household size indicated the number of people living under one household head. The results are presented in Table 11.

Table 11

Household Size

	Household size		Adults number		Children number	
Category	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
1-4	39	11.1	187	54.0	250	81.4
5-8	208	59.4	126	36.4	53	17.3
9-12	78	22.3	31	9.0	3	1.0
13-16	21	6.0	2	0.6	1	0.3
>16	4	1.1	0	0	0	0
Total	**350**	**100.0**	**346**	**100.0**	**307**	**100.0**

The results in Table 11 indicate that the average household size was 9 people per household. About 60 percent of the respondents' households' had 5-8 persons. The results in the Table 11 Vindicate that 11.1 percent of the households had 1-4 persons and those with more than 12 persons were 7.1 percent.

4.2.5 Household Size between the FFS and NFFS participants

The households were categorized into the FFS and Non FFS respondents. This was important in understanding the demographic parameter under study. The results are presented in Table 12.

Table 12

Distribution of FFS and NFFS Participants by household Size

	Frequency			Percent		
Household size	**FFS**	**NFFS**	**Both**	**FFS**	**NFFS**	**Both**
1 – 4	19	21	40	10.9	11.7	11.1
5 – 8	104	109	213	55.0	60.6	59.2
9 – 12	39	40	79	21.7	22.2	21.9
13 – 16	15	8	23	8.3	4.4	6.4
> 16	3	2	5	1.7	1.1	1.4
Total	180	180	360	100	100	100

Key: FFS –Means Farmer Field School Participant. NFFS – means Non Farmer Field School Participant. Both –means FFS and NFFS combined, to reflect the overall results.

The results in Table 12 indicate that the households with 5-8 persons form the largest categories for both FFS and NFFS with 55.0 percent and 60.6 percent respectively. For combined FFS and NFFS respondents, the results were 59.2% in this category. Large household size was expected to adopt and practice S&CM technologies more than small size households due to more labour availability. A larger family, in contrast to labour availability, would spend more income on basic needs than availing extra income to invest in the newly introduced S&CM technologies. In the case where the technology is labour intensive and cost saving, then there is a high expectation of adoption and impact being realized. A large family therefore could favour adoption of a labour intensive technology rather than a high cost technology.

4.2.6 Level of formal education of the respondents

Education is a very important parameter for technology adoption assessment and hence greater impact among the small scale farmers in the study locations. The frequency and percentage distribution of the level of education attained by the respondents were analysed and the results are shown in Table 13.

Table 13

Education level for farmers in study locations of North Rift Valley, Kenya

Level of Education Years in school	Frequency FFS	 NFFS	Percent FFS	 NFFS
0 (Never went to school)	7	6	3.9	3.3
1-4 (Lower primary level)	23	28	12.8	15.6
5- 8 (Upper primary level)	60	60	33.3	33.3
9-12 (Secondary level)	80	68	44.4	37.8
13-16 (College/Univ. level)	10	18	5.6	10.0
Total	**180**	**180**	**100**	**100**

Key: **FFS –** Farmer Field School participants. **NFFS** – Non FFFs participants

The results in Table 13 shows that 12.8 percent of the FFS participants as compared to 15.6 percent of the NFFS participants had only attended upto lower primary level (1-4) years of schooling only. The results on further comparison between the FFS and NFFS participants indicated that there was no clear defined trend in the years spent by the both category of respondents, although the results indicate that FFS participants had attained a higher level of education as compared to NFFS participants. Results in Table 13 further indicate that 44.4 percent of the FFS had attained the secondary level of education (9-12 years) of schooling as compared to 33.3 percent of NFFS. The results further show that only 3.9 percent of the FFS and 3.3 percent never went to school, hence it means that more than 95 percent of the respondents reported to have gone to school. Therefore the results in Table 13 shows that most of the respondents were generally literate.

The expectation is that higher level of education would influence positively adoption and practice of S&CM technologies while low level of education could mean low adoption of technologies. The study found that most of the respondents were of primary level of education, with very few of the respondents attaining higher level of education. This, therefore, means that education could influence dissemination and adoption and practice of S&CM technologies moderately. In conclusion on the education level, the results show that the majority respondents had attained a formal education. The studies that used interaction variables between extension and farmers' schooling generally found a net substitution relationship. Higher levels of farmer schooling reduced the impact of extension, and vice versa. This is consisted with findings of (Davis *et al* 2010) that FFS program not only allowed people with low education to participate but led to significant benefits in terms of income and crop and livestock productivity. The FFS program can be used to target low-education groups. This is contrary to the conventional wisdom, which says that FFSs are better suited for people with higher education levels, because of the semi-formal nature of the education that takes place. Apparently the demonstration sites, experiential learning methods, group approaches, and other factors make up for this and allow low-literacy people to participate and benefit from the interactions and exchange of ideas and knowledge.

4.2.7 Household income

House hold income is an important factor since it enables farmers to acquire the factors of production for running their farming activities. Epeju (2003) stated that socio-economic level of the farmers was understood through their level of income and social responsibility in their communities. In relation to this study farmers with higher income were expected to invest in new agricultural technology for improvement of their agricultural productivity. An interview schedule was used to collect data pertaining to income. The main sources of income identified were mainly farming, Salary from employment, small-scale business, petty trade and assistance by relatives. The results on income parameter are presented in Table 14.

Table 14:
Annual Income for all the Respondents

Activity	N	Minimum	Maximum	Mean	Std. Error
Farming	360	0	850,000	95678.85	6907.15
Salary from employment	39	2,400	240,000	76702.56	10350.49
Small-scale business	37	2,000	240,000	35805.41	7550.13
Petty trade	11	3,000	120,000	34490.91	10685.47
Assistance by relatives or Lenders	21	0	36,000	11909.52	1927.64
Total Income	**360**	**.00**	**850000.00**	**114970.51**	**7327.92**

The results revealed that most farmers had an average annual income of Kshs.114, 970 (Table 14) which represents a medium to low income. The expectation in this study therefore was a moderate adoption and impact of S & CM technologies among the farmers in the study area. All the respondents as shown in Table 13 engaged in farming. Other source of income for a minority of the respondents was salary from employment, small scale business, petty trade and assistance by relatives or lenders. The household income was further categorized into the FFS and Non FFS Participants. This enabled a comparative study to be carried out. The results are presented in Table 14.

Table 15
Annual Household Income (Kshs) among the Respondents in North Rift, Kenya

Range	**Frequency**			**Percent**	
	FFS	**NFFS**	**Both**	**FFS**	**NFFS**
< 40,000	60	59	119	33.3	32.8
40,001-80,000	53	59	112	29.4	32.8
80,001 – 120,000	12	22	34	6.7	12.2
120,001 – 160,000	7	11	18	3.9	6.1
160,001 – 200,000	12	4	16	6.7	2.2
200,001 – 240,000	6	2	8	3.3	1.1
240,001 – 280,000	7	4	11	3.9	2.2
280,001 – 320,000	3	4	7	1.7	2.2
320,001 – 360,000	3	6	9	1.7	3.3
360,001 – 400,000	4	2	6	2.2	1.1
400,001 –440,000	2	2	4	1.1	1.1
440,001 – 480,000	3	3	6	1.7	1.7
480,001 – 520,000	0	0	0	0.0	0.0
520,001 – 560,000	2	2	4	1.1	1.1
560,001 – 600,000	2	0	2	1.1	0.0
> 600,000	4	0	4	2.2	0.0
Total	**180**	**180**	**360**	**0.0**	**100.0**

Mean = KShs 114,970.51, **SD** = 57,540, **Minimum** = KShs 4,650,

Maximum = KShs 588,200

The annual household income as shown in (Table 15) revealed that 33.1 percent of the FFS households and 32.8 percent of the NFFS households had total annual income of less than Ksh 40,000.The results in the Table 15 further indicate that 29.4 percent the FFS and 32.5 percent of the NFFS households earned an income of between KShs. 40,001-80,000. The lowest household income earned by both groups was Ksh. 4,650 while the highest income earned was Ksh 588,200. However, the total annual household income was highly variable with a standard deviation of Ksh. 57,540. The households who earned salaries from formal employment mainly contribute to the variation. The comparative results between the FFS and NFFS households as indicated in Table 15 shows that the FFS households have a higher income than the NFFS households. In the household income categories of Kshs.160, 001 - 200,000 to over Kshs. 600,000 the FFS households have generally percentage of 26.7 percent compared to the NFFS which when added up have 16.6 percent. Farmers with higher income are expected to adopt and practice new agricultural technologies faster and at higher level of adoption and showing a greater impact in their farming system than the farmers with low income.

4.3 An Introduction on the procedures for the Data Analysis of the Study

This section covers the analysis of the objectives and hypotheses formulated for the study. There were five objectives and also five related hypotheses. The first objective was formulated to determine and compare the impact of the Soil and Crop Management Technologies promoted through FFS approach on the knowledge and skills of the FFS participants and Non FFS Participants in the study locations of the North Rift, Kenya. A common agricultural knowledge test instrument in (appendix B page 147) was designed and administered to the respondents. The test was set and read to the respondents as statement for them to answer accordingly. The short test was to gauge the understanding of FFS Participants in comparison to non-FFS farmers in terms of knowledge acquired in S&CM technologies and utilized to improve the agricultural productivity. The first hypothesis was designed to find out if there was any significant difference in their means between FFS participants and Non-FFS participants in knowledge and skill acquired in S&CMTs disseminated through the Farmer Field School approach in the study locations. The means were obtained by administering an interview schedule on the level of knowledge acquired from S&CMTs disseminated through conventional and FFS approaches. The knowledge was measured by use of a five point likert scale and results were recorded. The means were obtained after the analysis and were subjected to a t-test to find if there was any significant difference between the two groups of participants.

The second objective was concerned with finding out the impact of the Soil and Crop Management technologies promoted through FFSs approach on farm system of FFS participants before and after participating in FFSs in North Rift of Kenya. The farming system was operationalized as farm practices related to maize, vegetable and fodder production of the FFS participants before and after participating in Farmer Field School training. This objective goes with the formulation of the second hypothesis designed to test if there was any statistically significant difference between FFS participants before and after participation in FFSs on their Farming System (i.e farm practices related to maize, vegetable and fodder production) as a result of the impact of S&CM technologies disseminated through FFS approach in the study locations. The results were recorded after the analysis and presented in details in this study.

The third objective was aimed at finding out and comparing the impact of Soil and Crop Management Technologies, promoted through FFS approach on productivity (i.e farm income related to maize, vegetables and fodder production) of the FFS participants before and after participating in FFSs in the study locations. This was achieved by administering an interview schedule on productivity measured in terms of farm income related to maize, vegetables and Fodder production. Quantitative measurement was done by use of a five point likert scale and results were recorded. The third hypothesis was designed to test if there was any statistically significant difference between FFS participants before and after participation in FFSs on their productivity in terms of farm income related to maize, vegetables and fodder production as a result of the impact of S&CM Technologies disseminated through FFS approach in study locations.

The fourth objective was mainly “to determine and compare the impact of Soil and Crop Management Technologies, promoted through FFS approach on productivity (related to level of production per unit area for maize, vegetables and Napier grass (fodder) of the FFS participants before and after participation in FFSs and non FFS participants in study locations. This was achieved by administering a questionnaire on productivity measured in terms of per unit area production of maize, vegetables and Napier grass. Quantitative measurement was done by use of a five point likert rating scales measuring the Level of impact on farm productivity per unit area as a result of use of S&CMTs for FFS Participants before FFS and after FFS training and Non FFS participants. The three levels of participation were analysed by the fourth hypothesis to find out if there was any significant differences in their means through the use of one way analysis of variance (ANOVA). The results are presented in details in this study.

The fifth objective was designed to find out if there was any influence of socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) on the level of practice of Soil and Crop Management Technologies, promoted through FFS approach in the study location. The socio-economic factors analysed were: attitude towards change of their existing farming system, weighted gender role of respondents in participation in agricultural and domestic household activities, household income, farm size, age of farmer and years spent in school. A descriptive analysis for all the socio-economic factors selected for the study was done. The fifth hypothesis was designed to test if there was any statistically significant influence of selected socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) of the FFS participants and Non FFS participants on the impact of Soil and Crop Management Technologies promoted through FFS approach in the study locations. A multiple regression analysis was used to determine the contribution of each independent variable. The results are presented in details in this study.

The Soil and Crop Management Technologies (S&CMTs) studied for impact study included: 1) Compost making and utilization, 2) Soil conservation through: Fanya juu /channel terracing, Grass strips, Contour farming and On-farm tree planting. 3) Improved pasture establishment on: (i) Napier grass establishment and management (ii) Tumbukiza method for napier grass planting and (iii) Planting of Rode grass/desmodium 4) Vegetable growing (i) Nursery management (ii) Transplanting (iii) Pest and disease control (iv) Harvesting and marketing 5) Growing of alternative legumes e.g. (i) Soybean,

(ii) Dolicos lablab and (iii) Cowpeas 6) Use of plant extract (ITK) for control of insect pests in: (i) Kales. (ii) Local vegetables i.e. "Sucha" and (iii) Maize (7) Correct maize varieties for their area (AEZ): e.g. Hybrid 614, 628, 626, 625 or 511, 512, 513, (8) Organic/Inorganic fertilizers in; (i) Maize and (ii) Vegetables and Napier grass grown by ''Tumbukiza" method 8) Correct spacing for the following crops: (i) Maize, (ii) Cabbages and (iii) Napier grass.

4.3.1 Analysis of Impact of S&CMTs on Knowledge of the FFS and Non FFS Participants

The first objective of the study was stated as follows: "to determine and compare the impact of the Soil and Crop Management Technologies promoted through FFS approach on the knowledge and skills of the FFS participants and Non FFS Participants in North Rift of Kenya".

The test on knowledge and skills acquired through FFS approach and the normal conventional extension training approach between FFS-participants and non-FFS participants was done through administering a test to all the respondents. The objective sought to gauge the impact of the Soil and Crop Management technologies promoted through FFS approach in terms of knowledge and skills gained, retained and utilized by the respondents. The test consisted of twenty questions on common agricultural knowledge and soil and crop management technologies disseminated to the farmers in the study locations through FFSs or conventional extension training. The indicator on impact of the Soil and Crop Management technologies was measured through the Level of knowledge acquired by FFS and Non FFS farmers in S&CMTs as a result of the FFS and conventional extension training in the North Rift, Kenya.The statements were read to the respondents carefully by the interviewer and their responses were recorded.

The results are presented in Table 16.

Table 16
Level of knowledge acquired by FFS and Non FFS farmers in S&CMTs in the study locations of North Rift, Kenya.

Statement	Respondent FFS (%)	Respondent Non-FFS (%)
1: FFS is meant for all categories of farmers irrespective of age, gender and economic status	98.9	94.4
2: The procedure of making compost is that ...	70.6	55.6
3: Compost is easy to make and it is mainly used for growing vegetables	42.2	50.0
4:Agro-ecosystem analysis (AESA)/ demonstrations is the "heart" of the FFS/EXT	97.2	68.9
5: Every FFS/crop demonstration must have a study field/plot for farmer(s)	97.2	68.9
6: All insects are harmful to plants	97.2	84.4
7: Terracing, Contour farming, crop rotation and cut-off drain are all physical measures of soil con.	91.1	67.2
8: Soil is plant food	21.1	20.6
9: Soil conservation increase agricultural yields in the long run	96.7	95.6
10: Hybrid seed maize (H511, 512 and 513) varieties are suitable for high altitude region	81.7	80.6
11: Control of weeds early in the season helps the development of the maize plants	98.3	98.3
12: Stalk borer is a worst enemy of a bean plant as opposed maize	94.4	90.6
13: Aphids seriously attack maize more than beans during the dry spell	93.3	84.4
14: Measurement of a vegetable nursery width should be 1meter for easy management	91.1	84.4
15: "Karate" (insecticide) kills all insects irrespective of useful insects like bees	83.3	86.7
16: Every time we see insect in the maize or in our vegetable fields we should spray insecticides	77.8	50
17: Higher plant density of maize will always result in higher yields	80.6	59.4
18: It is safe to mix and apply pesticide without wearing protective clothing's e.g. boots	86.7	71.1
19: For germination of maize and beans to occur we require moisture	96.1	95.6
20: "Tumbukiza" is a method of planting napier grass	97.2	93.9
Means scores	**84.6**	**76.5**

The results in Table 16 indicate that the mean score for FFS participants was 84.6 percent and 76.5 percent for non FFS participants. The results in Table 16 further indicated that higher percentage of the FFS participants score higher in 18 statements than the NFFS-participants, indicating that they had acquired higher knowledge than NFFS participants. On the other hand, the NFFS-participants scored slightly higher in the following two statements. "Compost is easy to make and it is mainly used for growing vegetables'' (50 percent) as compared to (42.2 percent) for FFS participants and "*Karate* (insecticide) kills all insects irrespective of useful insects like bees and ladybirds" (86.7 percent) as compared to (83.3 percent) for the FFS participants. The score for FFS participants and non FFS participants tied in only the statement that: ''Control of weeds early in the season helps the development of the maize plants'' by both scoring 98.3 percent. From the results it shows that even the NFFS participants also learn from the messages disseminated through either conventional or the FFS approaches.

From these results, the FFS participants appeared to have acquired higher knowledge. Whether this difference was significant or not was determined by testing hypothesis one.

4.3.2 Tests of Hypothesis on Knowledge between FFS and Non FFS Participants

Difference between FFS participants and Non-FFS participants in knowledge and skill acquired in S&CMTs disseminated through the Farmer Field School approach.

The null hypothesis stated that:

Ho_1 –There is no statistically significant difference between FFS participants and Non-FFS participants in knowledge and skill acquired in S&CMTs disseminated through the Farmer Field School approach in North Rift.

C) To determine and compare the impact of the Soil and Crop Management FFSs approach on the knowledge and skills of the FFS participants and Non FFS Participants in North Rift of Kenya

The data were obtained by administering an interview schedule on the level of knowledge acquired from S&CMTs disseminated through conventional and FFS approaches. A total of 10 statements concerning adoption and the application of SCMTs after the FFS training as shown in page 148 were used to determine the level of knowledge of both the FFS and NFFS respondents. The knowledge was measured by use of a five point likert scale to test the knowledge acquired in S&CMTs and its application by the respondents on their farms and the results were recorded. Some of the key knowledge rating concerning the S&CMTs were: the level of use of high quality compost for maize/vegetables growing on the respondents farms, mixing of farm yard manure and organic fertilizer at half rates for maize production, soil conservation methods for control of soil erosion in maize/vegetables and pasture in their farms (contour, grass strips, Unploughed strips, terrace & cut off drains, planting of legumes as a nitrogen fixing for improve soil fertility such as soya beans, "njahi" and cowpeas, selection of the suitable hybrid maize varieties for their area, Use of indigenous technical knowledge to identify and use plant extracts to control pests in vegetables and maize, Integration of fodder crops/improved pastures into farming system for livestock feed, improve soil fertility for increased milk production such as the "Tumbukiza" method for napier grass production and carrying out of field observation through Agro-ecosystem analysis (AESA) or small plot/demonstration adaptability trial by the respondents. The means were obtained through the analysis of the results. An independent t-test was used to determine whether the mean scores of the two groups of participants had any significant difference between them. The results of the test are presented in Table 17.

Table 17

Test of significance in the knowledge and skill acquired in S&CMTs between the FFS and NFFS participants in North Rift, Kenya

FFS Participation	N	Mean	Std. Deviation	Std. Error Mean
FFS participants	180	3.8303	0.74325	0.05540
NFFS participants	180	2.6323	0.92689	0.06909

t= 13.528 d.f. = 341.860 p= 0.000

The results in Table 17 indicate that the mean score for FFS participants was 3.83±0.06 and 2.63±0.07 for non FFS participants. Therefore by subjecting these two means to an independent t-test, the results shows that there was a significant difference between the mean scores for FFS-participants and non-FFS participants (t= 13.528, d.f. = 341.860, p= 0.000) at 0.05 level of significance. Therefore, from the t-test results, the null hypothesis is therefore rejected. It was concluded therefore that, the results indicate that there was a significant difference in knowledge and skill acquisition between the two groups with the FFS participants having acquired more knowledge than the non FFS participants. This shows that participation in FFS had raised the knowledge of the FFS farmer participants above that of the Non-FFS farmers who did not participate in the FFS training.

The results are consistent with other studies showing positive impact of FFS participants acquiring more knowledge than the Non FFS participants (Moumeni-Halali and Ahmadpour (2013); De Jager, 2007; Davis, 2006; Braun et al., 2005 and Van de Berg, (2002). Rola et al. (2002) conducted a similar study in Philippines to assess whether farmers learn and retain knowledge in FFS training and whether they pass it on to their fellow farmers. They found that FFS trained farmers faired better in a test of the knowledge learnt compared to the non FFS trained farmers. They attributed this to the characteristic of the FFS approach of using adult training techniques of "educating rather than instructing" which makes it suitable for passing on "knowledge-intensive technologies" to all categories of farmers even those who have little or no formal schooling. Feder et al. (2004) also reported similar findings and concluded that FFS graduates benefited more from the significantly higher knowledge acquisition of better pest management in Indonesia.

The FFS farmers in this study were expected to disseminate the knowledge and skills acquired to their neighbouring farmers who never attended the field schools. Diffusion of this S&CMTs to non FFS participants was expected. This findings about dissemination and diffusion of agricultural technologies is supported by many studies globallly. For example this is supported by Roling, (1990) who noted that the diffusion of innovations has had a large impact on extension practices.

According to Onduru, D.D., De Jager, A., Hiller, S. and Van den Bosch, R. (2012), in their study noted that FFSs are forums where small scale farmers meet at an agreed venue to learn about new technologies. Oduru et al 2012 further noted that FFSs based on tea commodity was initiated in Kericho County of Kenya, where tea farmers were trained through FFS approach on sustainable agricultural practices in order to achieve quality tea production. These FFSs have embraced a participatory approach that includes the demonstration of best sustainable practices on the tea farms. These FFSs have been upscaled to upto 798 schools to cover all the 66 Kenya Tea Development Authority (KTDA) managed factories. Since the project began in 2009. Onduru further reported that during the launch event, 144 farmers from 5 Farmer Field Schools graduated and received their certificates on sustainable agriculture. This shows that many commodity based development organization such as KTDA have embraced FFS approach as pathway for disseminating new technologies in Kenya.

In practice innovations diffuse from the progressive farmers to others. In support of this statement, Roling (1990) further noted that it was considered perfectly legitimate for extension workers to limit their activities to a small category of progressive farmers, and then other farmers would eventually be reached indirectly by autonomous diffusion on progress. Roling summarised by stating that diffusion works just like corrosion while the disseminator sleeps. Therefore by training a critical mass of farmers in the FFS approach and after graduating, they are expected to disseminate the learned technologies to other farmers. In this study on the promotion of S&CMTs through FFS approach was expected to promote farmer to farmer extension and hence causing a positive impact on productivity and farming system of all the farmers in the study locations.

4.3.3 Impact of S&CMTs on Farming System of FFS Participants before and after Participation

The impact of the Soil and Crop Management technologies promoted through FFSs approach on farm system (farm practices related to maize, vegetable and fodder production) of FFS participants before and after participating in FFSs.

This was achieved through the analysis of objective two. This objective was designed to find out from the respondents which of the Soil and crop management technologies disseminated and learnt through Farmer Field School approach had been adopted and they were practicing on their farms. The study also investigated the extent of practice of the newly introduced S&CMTs through FFS training approach on their farms. The researcher rated the overall extent and practice on the farm of each individual respondent.

The comparative analysis of changes in farming system related to increase of income as a result of farmers' participation in S&CMT FFSs were undertaken in this study. Analysis of these Soil and Crop Management technologies on the impact of farming system was carried out among the FFS participants before and after their FFS Participation. This was achieved through administering a questionnaire designed to measure the level of practice of the already disseminated S&CM technologies by the FFS respondents before joining and participating in the Soil and Crop Management Farmer Field Schools and after FFS participation. The main aim was to establish if there has been any change in farming system in terms of the extent and level of practice of these Soil and Crop Management technologies promoted through FFSs approach. The results of the analysis are presented in Tables 18.

Table 18

Average Expression of Impact before and after participation in FFSs on Farming System of FFS Participants in the North Rift, Kenya

Level of practice of SM&C Management technologies on-farm	NC		Percent LC		MC		HC		VHC	
	B	A	B	A	B	A	B	A	B	A
Compost making	51	1.9	28.2	2.5	17.4	27.7	2	40.3	1.3	27.7
Soil conservation Level of practice										
''Fanya juu'' level	69.4	30.1	20.8	9.6	6.9	21.2	2.8	32.2	0	6.8
Grass strip level	49.7	2.5	28.5	10.1	16.6	34.8	5.3	38.6	.0	13.9
Contour farming level	33.1	3.5	28.8	6.4	28.8	29.7	9.4	30.8	.0	29.7
On-farm tree planting level	35.0	0	34.4	10.8	22.3	28.9	8.3	41.6	.0	18.7
Improved pasture level of practice										
N. grass establishment level	44.5	4.0	36.0	9.2	18.9	27.7	.6	35.3	0	23.7
''Tumbukiza" level of practice	76.3	20.2	17.5	5.8	5.0	24.3	.6	28.9	.6	20.8
Rhode grass level of practice	65.2	15.9	25.2	16.5	7.1	21.3	2.6	31.1	.0	15.2
Vegetable growing Level of practice										
Nursery management	11.8	9.5	64.7	4.8	23.5	57.1	0	0	0	28.6
Transplanting Level of practice	34.8	1.7	40.9	6.9	20.7	28.7	3.7	36.2	0	26.4
Pest control Level of practice	31.1	.6	41.0	6.3	23.6	24.6	3.7	39.4	.6	29.1
Harvesting & marketing level	32.7	.6	40.1	8.5	23.5	27.8	3.7	33.5	0	29.5
Alternative legumes level of practice										
Soyabeans Level of practice	79.9	29.9	13.2	13.2	3.8	19.8	2.5	26.3	.6	10.8
Dolicos Level of practice	72.1	40.0	17.5	11.0	8.4	17.2	1.9	17.9	0	13.8
Cowpeas Level of practice	35.6	2.4	42.5	10.6	16.9	27.6	5.0	36.5	0	22.9
ITK Level of practice for										
Kales	71.7	27.6	18.7	8.6	8.4	16.7	.6	22.4	.6	24.7
Local vegetables	70.7	25.1	20.7	6.9	7.9	18.3	.6	24.0	.0	25.7
Maize	62.3	22.0	19.8	10.2	16.7	13.0	1.2	28.2	.0	26.6
Use of correct maize varieties	20.2	0	28.2	1.1	44.2	19.0	7.4	34.5	.0	45.4
Level of Organic/ inorganic fertilisers use in										
Maize	32.9	1.1	28.0	8.0	32.9	19.5	5.6	33.9	.6	37.4
vegetables	35.3	.6	39.1	5.2	21.2	22.4	4.5	39.1	0	32.8
Correct spacing level of practice for										
Maize	14.2	0	34.0	2.8	45.1	15.8	6.8	41.8	.0	39.5
Cabbages	39.6	6.9	35.2	9.2	21.4	16.8	3.8	42.2	0	24.9
Napier grass	42.8	.6	38.3	5.7	15.1	24.1	3.8	42.5	0	27.0

FFS respondent: n=180 Non FFS respondent: n =180
Key: A=After FFS Participation, B=Before FFS Participation. **NC = No change in level of practice** LC = **Low Change in level of practice** MC= **Moderate Change in level of practice, HC =** high Change **in level of practice VHC =** Very High Change in farming system in terms of the extent and level of practice (Incorporation of S&CMTs) as a result of the impact of the S&CM promoted through FFS approach.

The findings are presented in Table 18. Show a positive trend of higher level of practice of S&CM technologies by FFS participants after FFS training. The farmers who participated in FFSs and adopted the S&CM technologies and incorporated these technologies as part of their farming practices have since realized a much higher income as compared to their situation before they participated in FFS training. These S&CM technologies since it was initiation in 2002 may have had an impact on the farming system among the farmers in the study locations.

The results in Table 18 for example in the compost making technology, indicate that 51 percent of the farmers had no change in the level of practice in compost making as compared to only 1.9 percent in the no change category after participating in FFSs. The scenario changed greatly after the farmers participated in FFS training. The results after the FFS training as shown in Table 18 indicate that 40.3 percent of the respondents reported a very high change in the level of practice of S&CM technologies. On checking on the very high change category there was only 1.3 percent of the respondents before participating in FFS as compared 27.7 percent of the same category after FFS participation.

The same trend was observed for soil conservation measures, where the results in table 18 shows that 69.4 percent of the farmers were not practicing "Fanya Juu" method terracing method of soil conservation before they participated in the FFS training. From further scrutiny of the results, it shows that after undergoing FFS training 32.2 percent of the respondents showed a shift to the high level of practice of S&CM technologies on their farms.

In Table 18, the new technologies such as the use of alternative legumes and Indigenous Technical Knowledge (ITK) showed higher percentages at the No change category before participation in FFSs. The results show that soya beans level of practice was high in the No Change category with 79.9 percent before they participated in FFS but after participating in the FFS training, 19.8 percent of the respondents shifted to moderate level of practice, 26.3 percent to high level of practice of growing soya beans and finally 10.8 percent of the respondents were at Very high level of practice in growing soya beans.

For the use of ITK for control of pests shows high percentages in the No change in the level of practice for these technologies with 71.7 percent for kales, 70.7 percent for local vegetables (sucha) and 62.3 percent for maize. After farmer undergoing the FFS training, the results in Table 18 showed a shift to high level of practice of the use of ITK with 22.4 percent of the respondents for Kales, 24 percent for local vegetables and 28.2 percent for maize while in the Very high level of practice category results were 24.7 percent of the respondents for Kales, 25.7 percent for local vegetables and 26.6 percent for maize.

The same trend can be observed for '*'Tumbukiza"* method of establishing napier grass with 76.3 percent showed no change in the level of practice before FFS participation but after participating in the FFSs and learning about the technology 28.9 percent of the respondents reported a high level of practice and 20.8 percent were at very high level of practice of the technology. The results for the rest of the technologies such as use of organic/inorganic fertilizers, use of correct maize varieties and correct spacing for maize, cabbages and napier grass as observed in Table 18. The results indicate generally a positive trend in the level of practice after the farmers were trained and graduated from farmer field schools.

4.3.4 Analysis of impact S&CMTs on Farming System of FFS and Non FFS Participants

Ho_2 - There is no statistically significant difference between FFS participants before and after participation in FFSs on their Farming System (farm practices related to maize, vegetable and fodder production) as a result of the impact of S&CM technologies disseminated through FFS approach in North Rift, Kenya.

Determination of level of change/impact in their farming system between FFS participants before and after participation in FFSs as a result of the impact of S&CMTs disseminated through FFS approach in study locations of North Rift Districts of Kenya.

A Paired t-test was used to determine if there was any impact in the farming system between FFS participants before and after participation in FFSs as a result of the S&CM

technologies dissemination through the FFS approach in the study location. The results are presented in Table 19.

Table 19

Test for impact on the farming system between FFS participants before and after FFS participation

Categories of participants	N	Mean	Standard deviation	Std Error Mean	2-tailed probability
Before FFS participation	179	1.9650	67155	.05019	.000
After FFS Participation	179		85213	.85213	

(*) Significant at the .05 level.) , t=-20.611, d.f. = 178 p = 0.000

The findings in Table 19 indicated that there was a significant difference between FFS participants before and after participation in FFSs on their Farming System (farm practices/enterprises) as a result of the impact of S&CM FFS dissemination approach in the study area of North Rift, Kenya (t=-20.611, d.f. = 178, p = 0.000). For this reason, the null hypothesis was rejected. This means that participation in FFS training brought about a significant change in the farming system as a result of the impact of S&CM technologies promoted through FFS approach.

4.3.5 Analysis of objective related to the impact of SCMT on productivity before and after FFS participation

The impact of SCMT promoted through FFS approach on productivity before and after participation.

The third objective was: "To determine and compare the impact of Soil and Crop Management Technologies, promoted through FFS approach on productivity (farm income related to maize, vegetables and fodder production) of the FFS participants before and after participating in FFSs in North Rift of Kenya".

This objective was designed to find out from the respondents which of the Soil and crop management technologies disseminated through Farmer Field School approach had an impact on farm productivity related to income of FFS and Non participants as a result of incorporating the S&CMTs into their farming system. The study also investigated if the Soil and Crop Management technologies disseminated through FFSs had any change in farm productivity of FFS participants. The level of change in productivity was measured through a five point likert scale tool administered to the respondents to compare their productivity before FFSs participation and after FFS Participation. The researcher interviewed the respondents and rated their responses on the level of change in productivity of all the soil & crop management technologies promoted through the various FFSs in the study locations. The results are presented in Tables 20 to 28.

Table 20

Comparison of Compost making and use by FFS Participants before and after FFS Participation

Soil & Crop Management Technologies- Compost making	**Level of change in productivity related to income**	**Before FFS P**		**After FFS P**	
		Frequency	Per cent	Frequency	Per cent
Compost making, use & level of Change in productivity related to income	No change	90	50.0	3	1.7
	Very little change	49	27.2	4	2.2
	Moderate change	34	18.9	50	27.8
	High Change	5	2.8	71	39.4
	Very high Change	2	1.1	52	28.9
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 20 shows the responses on compost making and level of use as an organic fertilizer on maize and vegetables by the farmers. The results revealed that for compost making and use farmers participated in FFSs, 50 percent of the respondents said they had no change in their level of productivity as compared to only 1.7 percent in the same category after in soil and crop management FFSs. In contrast, after the farmers enrolling and participating in FFSs, the results indicate that 39.4 percent of the farmers had shifted to the high level of productivity while 28.9 percent were at very high levels of their farm productivity. This shows a positive impact of S&CM technology in particular the compost making.

Table 21

Methods of Soil conservation Practice of FFS Participants before and after FFS participation

S&CMTs-Soil Conservation Methods	Level of change in productivity related to income	Before FFS P		After FFS P	
		Frequency	Per cent	Frequency	Per cent
‘‘Fanya juu’’ level of change in productivity related to income	No change	124	68.9	53	29.4
	Very little change	39	21.7	18	10.0
	Moderate change	13	7.2	39	21.7
	High Change	4	2.2	58	32.2
	Very high Change	0	.0	12	6.7
	Total	**180**	**100.0**	**180**	**100.0**
Grass strip level change	No change	91	50.5	6	3.3
	Very little change	50	27.8	18	10.0
	Moderate change	29	16.1	64	35.6
	High Change	9	5.0	68	37.8
	Very high Change	1	0.6	24	13.3
	Total	**180**	**100.0**	**180**	**100.0**
Contour farming level change	No change	58	32.2	6	3.3
	Very little change	52	28.9	13	7.2
	Moderate change	53	29.4	52	28.9
	High Change	16	8.9	57	31.7
	Very high Change	1	0.6	52	28.9
	Total (N)	**180**	**100.0**	**180**	**100.0**
On-farm tree planting level change	No change	62	34.4	0	0
	Very little change	61	33.9	18	10.0
	Moderate change	41	22.8	53	29.5.
	High Change	16	8.9	74	41.1
	Very high Change	0	.0	35	19.4
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The result in Table 21 shows the extent and level of practice for soil conservation technologies by farmers. The results revealed that for ‘‘Fanya juu’’ method of soil conservation before farmers participated in FFSs, 68.9 percent of the respondents said they had no change in their level of productivity as compared to 29.4 percent in the same category after participating in soil and crop management FFSs. In contrast, after the farmers enrolling and participating in FFSs, the results in Table 21 indicate that 32.2 percent of the farmers had shifted to the high and 6.7 percent to very high levels of their farm productivity categories respectively.

The results in Table 21 further revealed that for grass strip method of soil conservation before farmers participated in FFSs, 50.5 percent of the respondents said they had no change in their level of productivity as compared to only 3.3 percent in the same category after participating in soil and crop management FFSs. In contrast, After the farmers enrolling and participating in FFSs, the results in Table 21 indicate that 37.8 percent of the farmers had shifted to the high and 13.3 percent to very high levels (VHL) of their farm productivity categories respectively. This grass strip technology showed a high response since combining the three categories of moderate, high and very high change responses after the farmers participation in FFSs results add up to 86.7 percent. These shows a high practice of grass strip soil conservation measures by the farmers in the study locations. This high adoption and practice would be attributed to the less labour involved in the initiation of the technology.

The results in Table 21 for contour farming method of soil conservation show that before farmers participated in FFSs, 32.2 percent of the respondents said they had no change in their level of productivity as compared to only 3.3 percent in the same category after participating in soil and crop management FFSs. In contrast, after the farmers enrolling and participating in FFSs, the results in Table 21 indicate that 31.7 percent of the farmers had shifted to the high and 28.9 percent to very high levels (VHL) of their farm productivity categories respectively.

The same trend as in contour farming is observed for on-farm tree planting method of soil conservation where the results in Table 21 shows that before farmers participated in FFSs 34.2 percent of the respondents said they had no change in their level of productivity as compared to no farmer in the same category after participating in soil and crop management FFSs. In contrast after the farmers enrolling and participating in FFSs, the results in the table indicate that 41.1 percent of the farmers had shifted to the high and 19.4 percent to very high levels (VHL) of their farm productivity categories respectively. This on-farm tree planting technology showed a high response since combining the three categories of moderate, high and very high change responses after the farmers' participation in FFSs results add upto 90.0 percent with no farmer in the no change category. This shows that farmers have now taken tree planting as part of their farming practices in the study locations. This shows a positive trend on the impact of S&CM technologies in particular the soil conservation measures. These results were subjected to t- tests to establish if there were any significant differences in the means before and after participation.

Table 22

Productivity of improved pastures and Fodder of FFS Participants before and after FFS participation

		Before FFS P		After FFS P	
S&MCTs - Fodder production	**Level of change in productivity related to income**	**Frequency**	**Per cent**	**Frequency**	**Per cent**
Napier grass establishment level of change in productivity	No change	78	43.3	6	3.3
	Very little change	64	35.6	18	10.0
	Moderate change	36	20.0	52	28.9
	High Change	2	1.1	61	33.9
	Very high change	0	0.0	43	23.9
	Total (N)	**180**	**100.0**	**180**	**100.0**
Tumbukiza method of fodder production level of change	No change	134	74.4	34	18.9
	Very little change	34	18.9	9	5.0
	Moderate change	9	5.0	45	25.0
	High Change	2	1.1	55	30.5
	Very high Change	1	.6	37	20.6
	Total	**180**	**100.0**	**180**	**100.0**
Rhode grass level of change in productivity	No change	113	62.8	28	15.6
	Very little change	46	25.5	29	16.1
	Moderate change	14	7.8	39	21.7
	High Change	6	3.3	58	32.2
	Very high Change	1	0.6	26	14.4
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 22 show the comparison before and after FFS participation with regards to improved pasture and fodder productivity related to increased income. For Napier grass establishment level of change in productivity, the results revealed that before farmers participated in FFSs, 43.3 percent and 35.6 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively, as compared to 3.3 percent and 10 percent in the same category respectively, after participating in soil and crop management FFSs. In contrast, after the farmer participating in FFSs training, the results in Table 22 indicate that 33.9 percent of the farmers had shifted to the high and 23.9 percent to very high levels (VHL) of their farm productivity categories respectively.

The same trend was observed for *Tumbukiza* method of napier grass establishment where the results in Table 22 shows that before farmers participated in FFSs 74.4 percent of the respondents said they had no change in their level of productivity as compared to 18.9 percent in the same category after participating in soil and crop management FFSs. In contrast, after the farmers enrolling and participating in FFSs, the results in Table 22 indicate that 30.5 percent of the farmers had shifted to the high and 20.6 percent to very high levels (VHL) of their farm productivity categories respectively. When the three categories of moderate, high and very high change responses after the farmers' participation in FFSs are combined the results was 76.1 percent. Notably, 18.9 percent and 5.0 percent of the farmers remained at the no change and very little change categories respectively. This ''*tumbukiza"* method of napier grass establishment technology showed a fairly high response. This show**s** that farmers have adopted this method though quite a number of them are still watching and yet to adopt. This trend is normal and is in agreement with (Rogers 2003) adoption theory where a new technology takes time lapse before being accepted by a category of farmers ranging from innovators, early majority, and late majority to the laggards who will not accept change.

Further the results in Table 22 indicate that for rhode grass establishment, the results indicated that 62.8 percent of the farmers had no change in their level of productivity before participating in FFSs as compared to 15.6 percent in the same category after participating in soil and crop management FFSs. The shows shift from no change of

S&CMTs to In contrast after the farmers enrolling and participating in FFSs, the results in the Table 22 indicate that 32.2 percent of the farmers had shifted to the high and 14.4 percent to very high levels (VHL) of their farm productivity categories respectively.

Table 23

Productivity of vegetable growing practices of FFS Participants before and after FFS Participation

		Before FFS P		After FFS P	
Soil &Crop Management Technologies-Crop Management practice	**Level of change in productivity related to income**	**Frequency**	**Percent**	**Frequency**	**Percent**
Nursery management level of Change in productivity related to income	No change	22	12.2	18	10.0
	Very little change	115	63.9	8	4.4
	Moderate change	40	22.2	101	56.1
	High Change	2	1.1	53	29.5
	Very High Change	1	0.6	0.0	0.0
	Total	**180**	**100.0**	**180**	**100.0**
Transplanting level of change in productivity related to income	No change	61	33.9	4	2.2
	Very little change	70	38.9	11	6.1
	Moderate change	39	21.7	51	28.3
	High Change	8	4.4	66	36.7
	Very high Change	2	1.1	48	26.7
	Total (N)	**180**	**100.0**	**180**	**100.0**
Use of ITK in pest control level of change in productivity related to income	No change	57	31.7	1	0.6
	Very little change	73	40.6	12	6.7
	Moderate change	42	23.3	43	23.9
	High Change	6	3.3	70	38.9
	Very high Change	2	1.1	54	30.0
	Total (N)	**180**	**100.0**	**180**	**100.0**
Harvesting & marketing of maize, Vegetables and Napier grass level of Change in productivity related to income	No change	58	32.2	1	0.6
	Very little change	71	39.5	17	9.4
	Moderate change	42	23.3	49	27.2
	High Change	7	3.9	61	33.9
	Very high Change	2	1.1	52	28.9
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 23 show Crop Management practices. In particular, these crop management practices included nursery management, transplanting, use of Indigenous

Technical Knowledge (ITK) in pest control and harvesting & marketing of maize, vegetables and napier grass. The aim was to establish Level of change in productivity related to income as a result of farmers undergoing training on Soil and Crop management Farmer Field Schools. The level of Change in productivity related to income was measured using a five point likert scale tool. The results in Table 23 revealed that for nursery management level of change in productivity, the results revealed that before farmers participated in FFSs, 12.2 percent and 63.9 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively as compared to 3.3 percent and 10 percent in the same category respectively after participating in FFSs training. In contrast, after the farmer participating in FFSs training, the results in Table 23 indicate that 56.1 percent of the farmers had shifted to the moderate and 29.5 percent to high levels of their farm productivity categories respectively. There was no farmer in the very high level of change but 10 percent said they had no change even undergoing FFS training. This shows that farmers had fallen back to their conventional way of practice in nursery management.

The use of alternative legumes other than beans for improve soil fertility**,** where three legumes were investigated to establish if there was an impact in productivity as a result of farmers being trained in Farmer Field Schools. Specifically the three legumes crop included soya beans, dolicos lab lab and cowpeas. The level of Change in productivity related to income was measured using a five point likert scale. The results are presented in Table 24.

Table 24

Productivity of alternative legumes of FFS Participants before and after FFS Participation

S&CM Ts-Alternative legumes other than beans	Level of change in productivity related to income	Before FFS P		After FFS P	
		Frequency	**Per cent**	**Frequency**	**Per cent**
Soya beans level of change in Productivity related to income	No change	140	77.8	53	29.4
	Very little change	26	14.4	21	11.7.
	Moderate change	8	4.5	38	21.1
	High change	5	2.7	48	26.7
	Very high change	1	0.6	20	11.1
	Total	**180**	**100.0**	**180**	**100.0**
Dolicos Lab Lab level of Change in Productivity related to income	No change	128	71.1	71	39.4
	Very little change	32	17.8	21	11.7
	Moderate change	16	8.9	30	16.7
	High change	3	1.6	33	18.3
	Very high change	1	0.6	25	13.9
	Total	**180**	**100.0**	**180**	**100.0**
Cowpeas level of change in productivity related to income	No change	62	34.4	3	1.7
	Very little change	75	41.6	21	11.7
	Moderate change	32	17.7	48	26.6
	High change	10	5.6	67	37.2
	Very high change	1	0.6	41	22.8
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 24 revealed that for soya bean growing level of change in productivity, the results showed that before farmers participated in FFSs, 77.8 percent and 14.4 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively. While after FFS participation, 29.4 percent and 11.7 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively. In contrast, after the farmer participating in FFSs training, the results in Table 24 indicate that 26.7 percent of the farmers had shifted to the high and 11.1 percent to very high levels of their farm productivity categories respectively. This result shows that growing soya beans as a legume did not attract more farmer interests as compared to dolicos lab lab and cowpeas.

The same trend was observed for dolicos lab lab and cowpeas growing. For dolicos lab lab the results indicated that before farmers participated in FFSs 71.1 percent of the respondents said they had no change in their level of productivity as compared to 39.4 percent in the same category after participating in soil and crop management FFSs. In contrast, for the same crop of dolicos lab lab, after the farmers' participation in FFSs training, the results in Table 22 indicate that 18.3 percent of the farmers had shifted to the high and 13.9 percent to very high levels (VHL) of their farm productivity categories respectively. Further results in Table 22 indicate that when the three categories of moderate (16.7 percent) high (18.3 percent) and very high (13.9 percent) change responses after the farmers' participation in FFSs were combined the results was 48.9 percent. Notably, 39.4 percent and 11.7 percent of the farmers remained at the no change and very little change categories respectively. This dolicos lab lab growing technology showed a moderate response. This shows this crop is still a new one and that farmers have slowly adopted the growing of this crop though about 50 percent are still watching and yet to make their decision to adopt the crop.

Further the results in Table 24 indicate that for cow peas growing, the results indicated that 34.4 percent of the farmers had no change in their level of productivity before participating in FFSs as compared to 1.7 percent in the same category after participating in soil and crop management FFSs. In contrast after the farmers enrolling and participating in FFSs, the results in Table 22 indicate that 37.2 percent of the farmers had shifted to the high and 22.8 percent to very high levels (VHL) of their farm productivity categories respectively. Further results in Table 24 for cow peas growing, indicate that when the three categories of moderate (26.6 percent) high (37.2 percent) and very high (22.8 percent) change responses after the farmers' participation in FFSs were combined the results was 86.6 percent. Notably, 1.7 percent and 11.7 percent of the farmers remained at the no change and very little change categories respectively. This shows that cow peas growing response was very high and give an indication that this crop is not a new crop to the farmers. This shows this crop was part of the cropping system and that farmers adopted the growing of this crop faster and only about 13.4 percent though about yet to make their decision to adopt the crop. This trend is normal and is in agreement with (Rogers 2003) adoption theory where a new technology takes time lapse before being accepted by a category of farmers ranging from innovators, early majority, and late majority to the laggards who will not accept change. This farmers remaining may be the laggards who will most likely no change.

The use of indigenous Technical knowledge (ITK) in identification of plant extracts to control pest in kales, local vegetables and maize was studied. The aim was to establish if FFSs training on the use of plant extracts for control of insect pests had an impact on productivity hence enhanced income. The results are presented in Table 25.

Table 25

Productivity of the use of ITK for control of insect pests in vegetables and maize for FFS Participants

S&CMTs-ITK on pest control	**Level of change in productivity related to income**	**Before**		**After**	
		Frequency	**Per cent**	**Frequency**	**Per cent**
Kales level of change in Productivity related to income	No change	126	70.0	51	28.3
	Very little change	36	20,0	15	8.3
	Moderate change	16	8.8	28	15.6
	High Change	1	.6	42	23.3
	Very high Change	1	.6	44	24.0
	Total (N)	**180**	**100.0**	**180**	**100.0**
local vegetables level of change in productivity related to income	No change	124	68,9	43	23.9
	Very little change	40	22.2	14	7.8
	Moderate change	15	8.3	34	18.9
	High Change	1	.6	41	22.7
	Very high Change	0	.0	48	26.7
	Total (N)	**180**	**100.0**	**180**	**100.0**
maize level of Productivity related to income	No change	110	61.1	38	21.1
	Very little change	34	18.9	20	11.1
	Moderate change	33	18.3	22	12.2
	High Change	2	1.1	52	28.9
	Very high Change	1	0.6	48	26.7
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 25 revealed that before the use of ITK in pest control in Kales 70 percent of the respondents had no change in their level of productivity as compared to 28.3 percent in the same category. In contrast, after the farmers enrolling and participating in FFSs, the results indicate that 23.3 percent of the farmers were in the high and 24.0 percent very high levels of their farm productivity respectively. The results for local vegetables indicated that 68.9 percent of the respondents had no change in their level of productivity as compared to 23.9 percent in the same category. In contrast, after the farmers enrolling and participating in FFSs, the results indicate that 22.7 percent of the farmers were in the high and 26.7 percent very high levels of their farm productivity respectively.

While for maize, the results indicate that 61.1 percent of the respondents had no change in their level of productivity as compared to 21.1 percent in the same category. In contrast, after the farmers enrolling and participating in FFSs the results indicate that 28.9 percent of the farmers were in the high and 26.7 percent very high levels of their farm productivity respectively. The results followed the same trend showing a positive impact of S&CM technology in particular the control of insect pest in Kales.

The use of correct maize varieties was disseminated through FFSs in the study locations. The aim was to establish the level of change in productivity related to income before and after adopting the use of correct maize varieties through FFS. The results are presented in Table 26.

Table 26

A comparison of level of productivity on the use of correct maize varieties by FFS Participants

		Before FFS P		**After FFS P**	
Soil & Crop Management Technologies	**Level of change in productivity related to income**	**Frequency**	**Per cent**	**Frequency**	**Per cent**
Correct maize varieties level of change in productivity related to income	No change	34	18.9	0	0
	Very little change	50	27.8	4	2.2
	Moderate change	81	45	32	17.8
	High change	14	7.7	64	35.6
	Very high change	1	0.6	80	44.4
	Total (n)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 26 on use of correct maize varieties by FFS Participants revealed that before the introduction of the technology 18.9 percent of the respondents had no change in their level of productivity as compared to no respondent after FFS participation in the same category. In contrast, after the farmers enrolling and participating in FFSs, the results indicate that 35.6 percent of the farmers were in the high and 44.4 percent very high levels of their farm productivity respectively. This shows a positive impact of S&CM technology in particular the use of correct maize varieties by the farmers in the study locations.

The use of half recommended rates of combination of organic and inorganic fertiliser on maize, Kales and cabbages was disseminated through FFSs in the study locations. The aim was to assess the level of change in productivity of these crops and income accruing from them. It was to ultimately establish if FFS training on the use of organic and inorganic fertilisers combination at half recommended rates as a technology had led to increased productivity and hence enhanced income in maize and vegetables. The results are presented in Table 27.

Table 27

Productivity on the use of organic/ inorganic fertilisers for Maize and Vegetables by FFS Participants

		Before FFS P		**After FFS P**	
Soil & Crop Management Technologies	**Level of change in productivity related to income**	**Frequency**	**Per cent**	**Frequency**	**Per cent**
Maize: level of change in productivity related to income	No change	58	32.2	2	1.1
	Very little change	50	27.8	14	7.8
	Moderate change	60	33.3	36	20.0
	High Change	11	6.1	60	33.3
	Very high Change	1	0.6	68	37.8
	Total (N)	**180**	**100.0**	**180**	**100.0**
Vegetables: kales and cabbages level of change in productivity related to income	No change	63	35.0	1	0.6
	Very little change	70	38.9	8	4.4
	Moderate change	37	20.5	41	22.8
	High Change	9	5.0	70	38.9
	Very high Change	1	0.6	60	33.3
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 27 show that the use of organic/ inorganic fertilizers on maize and vegetables and their impacts on level of productivity related to income. The results on use of the use of organic and inorganic fertilizers combination at half recommended rates on maize, revealed that before the introduction of the technology 32.2 percent of the respondents had no change in their level of productivity as compared to only 1.1 percent in the same category after participating in soil and crop management FFSs, In contrast, after the farmers enrolling and participating in FFSs, the results indicate that 33.3 percent of the farmers were in the high and 37.8 percent very high levels of their farm productivity respectively.

The results in Table 27 on use of the use of organic and inorganic fertilizers combination at half recommended rates on kales and cabbage vegetables, revealed that before the introduction of the technology 35.0 percent of the respondents said they had no change in their level of productivity as compared to only 0.6 percent in the same category after participating in soil and crop management FFSs, In contrast, after the farmers enrolling and participating in FFSs, the results indicate that 38.9 percent of the farmers were in the high and 33.3 percent very high levels of their farm productivity respectively. This shows a positive impact of S&CM technology in particular the use of organic and inorganic fertilizers combination at half recommended rates on the two vegetables for increased productivity.

The comparison of the adoption of the correct spacing for maize, cabbage and napier grass on productivity related to income before and after participation in FFS was studied. The aim was to establish if FFSs training on the adoption of correct spacing had an impact on productivity hence enhanced income. The results are presented in Table 28.

Table 28

Productivity on adopting correct spacing for selected crops by FFS Participants

Soil & Crop Management Technologies- Correct pacing practice	Level of change in productivity related to income	Before		After	
		Frequency	**Per cent**	**Frequency**	**Per cent**
Maize level of change in productivity related to income	No change	25	14.2	0	0.0
	Very little change	61	34.0	5	2.8
	Moderate change	81	45.1	29	15.8
	High change	12	6.8	75	41.8
	Very high change	0	0.0	71	39.5
	Total (N)	**180**	**100.0**	**180**	**100.0**
Cabbages level of change in productivity related to income	No change	71	39.6	12	6.9
	Very little change	63	35.2	17	9.2
	Moderate change	39	21.4	30	16.8
	High change	7	3.8	76	42.2
	Very high change	0	0.0	45	24.9
	Total (N)	**180**	**100.0**	**180**	**100.0**
Napier grass level of change in productivity related to income	No change	77	42.8	1	0.6
	Very little change	69	38.3	10	5.7
	Moderate change	27	15.1	43	24.1
	High change	7	3.8	77	42.5
	Very high change	0	0.0	49	27.0
	Total (N)	**180**	**100.0**	**180**	**100.0**

Key: FFS P-Farmer Field School Participation.

The results in Table 28 revealed that for adoption and practice of correct spacing for maize had impacted on the level of change in productivity, hence a higher yield of maize achieved by the respondents. The results in Table 28 shows that before farmers participated in FFSs, 14.2 percent and 34.0 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively. While after FFS participation, there was no respondent in the no change category while 2.8

percent of the respondents indicated that they had very little change in their level of productivity respectively. In contrast, after the farmer participating in FFSs training, the results in the Table 28 indicate that 41.8 percent of the farmers had shifted to the high and 39.8 percent to very high levels of their farm productivity categories respectively. These results revealed that the use of correct spacing for maize had created a positive impact.

For the use of correct spacing in cabbages, the results revealed that before farmers participated in FFSs, 39.6 percent and 35.2 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively as compared to 6.9 percent and 9.2 percent in the same category respectively, after participating in soil and crop management FFSs. In contrast, after the farmer participating in FFSs training, the results in Table 28 indicate that 42.2 percent of the farmers had shifted to the high and 24.9 percent to very high levels of their farm productivity categories respectively.

For the use of correct spacing in napier grass establishment, the results in Table 28 revealed that before farmers participated in FFSs, 42.8 percent and 38.3 percent of the respondents indicated that they had no change and very little change in their level of productivity respectively as compared to 0.6 percent and 5.7 percent in the same category respectively after participating in soil and crop management FFSs. In contrast, after the farmer participating in FFSs training, the results in Table 28 indicate that 42.5 percent of the farmers had shifted to the high and 27.0 percent to very high levels (VHL) of their farm productivity categories respectively.

In all crop management technologies indicated in Table 28, the majority of respondents reported an increase in income after participation in FFS. The dissemination of S&CM technologies through FFSs have resulted in positive impact on productivity related to these crops hence a reflection in the increase in income accruing from these crops for the the FFS participants.

The Key indicator in the adoption of S&CM practices is related to maize production. Investigation was conducted to ascertain income levels for maize production achieved by

FFS participants Before and After participating in FFS training. The results are presented in Table 29.

Table 29

Mean productivity of maize production of FFS participants before and after FFS participation

Income from Maize before and after in (KShs)	N	Mean	Std. Error
Income of maize per acre before	180	27380.5556	1791.89968
Income of maize per acre after	180	53038.8889	3455.04394

The results in Table 29 show that income before FFS participation was much lower than the income after participation. Further the results in the table indicate that before FFS participation the mean income was KES 27380.56±1791.90 which was about half of the income after the FFS participation KES 53038.89±3455.04. It clearly shows that, soil and crop management technologies promoted through FFS approach had high impact on maize productivity related to income. This is reflected in the higher income from maize production received by the FFS farmers. A study conducted by Davis, et al (2010) found out that overall, farmer field schooling had a significant impact on crop productivity in Kenya and Tanzania. The value of crop productivity per acre for farmers participating in an FFS increased by about 80 percent in Kenya, an increase that demonstrates the schools' potential in increasing maize productivity hence impact on productivity was realized. In Tanzania, the value of crop productivity for FFS members increased by 23 percent. Further the results in this study are consistent with several other studies showing positive effects of FFSs on productivity (Gockowski et al. 2006; Godtland et al. 2004; Ortiz et al. 2004; Yamazaki and Resosudarmo, 2006). In this study the income from maize increased substantially for the FFS Participants after FFS season long training on maize agronomic practices.

4.3.6 Productivity of maize in terms of Income of FFS Participants before and After FFS Participation

Ho$_3$ - There is no statistically significant difference between the FFS participants before and after participation in FFSs on their productivity in terms of farm income related to maize as a result of the impact of S&CM Technologies disseminated through FFS approach in North Rift.

In testing the above null hypothesis, income from maize yield per acres was converted to income was used as the dependent variable. A paired sample t-test was used to test the hypothesis before the farmers enrolled and participated in the farmer field schools and after FFS participation. The results are presented in Table 30.

Table 30

Paired sample t-test for differences in maize income before and after FFS participation

Maize income per acre	Mean	N	Std. Deviation	Std. Error Mean
Before participation	27380.56	180	24040.85698	1791.89968
After participation	53038.89	180	46354.27865	3455.04394

t=-10.240 d.f.=179 p=0.000

The findings indicate that the income received by farmers in relation to the maize production after FFS participation (53038.89±3455.04) was significantly higher than the income before participation (27380.56±1791.90). Hence the null hypothesis was rejected. Therefore it shows that farmers who enrolled and participated in FFS had higher income accruing from maize production due to the impact S&CM technologies on the farming systems. This implies that adoption and practicing of the S&CM technologies promoted through FFS approach is of greater benefit.

4.3.7 Impact of S&CMT on productivity of Maize per unit area between FFS and non FFS participants

The impact of SCMT promoted through FFS approach on productivity of FFS participants before, after participation and non FFS participants.

The four objective was: To determine and compare the impact of Soil and Crop Management Technologies promoted through FFS approach on productivity (related to level of production per unit area for maize, vegetables and Napier grass) of the FFS participants before and after participation in FFSs and non FFS participants in North Rift of Kenya.

This objective was designed to find out from the respondents which of the Soil and crop management technologies disseminated through Farmer Field School approach had an impact on farm productivity related to level of production per unit area for maize of the FFS participants before and after participation in FFSs and also for non FFS participants. The maize yield for every respondent was converted to income. The results are presented in Table 31.

Table 31

Production of maize (in 90kg bags) per acre of FFS and the Non FFS participants

Participation	Mean	N	Std. Error of Mean	Std. Deviation
FFS Participants before	11.7750	180	.42607	5.71636
FFS Participants after	19.8556	180	.58502	7.84887
Non FFS participants	12.0083	180	.38610	5.18013
Total	14.5463	540	.46573	6.2484

Key: one acre = 0.4 hectares and 1 bag of maize weighs 90kg.

The results in Table 31 indicate that the FFS Participants after participation had a higher mean number of bags (19.85), followed by non FFS-participants (12.00) and the lowest were FFS participants before participation (11.77). The Non FFS and FFS participants before undergoing FFS training indicate that they were almost having the same mean number of maize bags of 12 bags per acre which is equivalent to 30 bags per hectare.

4.3.8 Test of Hypothesis four to determine the impact of S&CMTs on productivity of Maize per unit area between FFS and non FFS participants

Ho4 – ''There is no statistically significant difference between FFS participants before and after participation in FFSs and Non FFS farmers on their productivity in terms of the level of production per unit area for maize as a result of the impact of S&CMTs promoted through FFS approach in North Rift''. The mean production of maize per unit area of the three groups was compared using one way analysis of variance (ANOVA). The results are presented in Table 32.

Table 32

Production per Acre (bags of maize) between FFS participants before and after FFS participation and the Non FFS participants

Group comparison Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7615.723	2	3807.862	94.320	.000
Within Groups	21679.619	537	40.372		
Total	**29295.343**	**539**			

N= 540

The results of ANOVA (Table 32) show a statistically significant difference between the means of the groups ($F=94.320$, $df=2$, $p=0.000$). Therefore the null hypothesis four was rejected. It was therefore concluded that there was a statistically significant difference in the means of the two groups.

In many FFFs which have been studied globally show that most FFS projects have shown evidence of positive impact on rural communities and sustainable agricultural development leading to improved income and livelihoods (Tripp et al., 2004., Mancini, 2006., Preternatural and Waibel, 2006). Van de Fliert (2002) noted that when aiming at achieving impact in farmers' fields, with impact implying both qualitative improvement of farmers' living conditions and quantitative measurements and coverage in terms of farm productivity and improved soil fertility management thus reflected in increased crop yields per unit area.

Onduru,. De Jager., Hiller & Van den Bosch R (2012) in their study, which explored whether farmers participation in FFS, and exposure to good agricultural Practices led to changes in productivity of tea. They found out that by a comparison between the "before FFS" and "after FFS" participation, revealed a significant positive change in tea productivity for FFS members (mean increase of 1297 kg ha-1, $p < 0.01$; t-test) but separately also for non-FFS members (mean increase of 1121 kg ha-1, $p < 0.05$; t-test). However, the overall increase in productivity above the baseline year ("before FFS") tended to be higher for FFS (19% increase) than non-FFS members (15% increase). From their findings it showed that participation in FFS enhanced tea productivity among the smallholders in the study location of Kericho County in Kenya.

In this study the main indicators of impact on productivity and farming system was maize yield per unit area measured in terms of hectares, level of change in productivity for kales, cabbages, local vegetables, fodder production such as napier grass and rhode grass.

4.3.9 Post hoc multiple comparison analysis

Subjecting the results to further post hoc multiple comparison analysis (Table 33), the results indicate that there is a statistically significant difference in the means of the FFS participants before and after FFS participation (p=0.000) and also between the Non FFS participants and the Participants after FFS training (p=0.000).

Results from the ANOVA and the post hoc multiple comparison analysis, it can be concluded with that, farmers who have underwent the FFS training are producing more bags of maize per unit area as compared to the same farmers before they undergo the FFS training. The non-participants and the FFS participants before FFS training are producing at the same level as shown in Table 33, where there is no statistically significant differences in their means (p=0.935).

Table 33

Post Hoc Multiple Comparisons

		Mean Difference	Std. Error	Sig.
FFS before	FFS after	-8.08056*	.66976	.000
	Non FFS	-.23333	.66976	.935
FFS after	FFS before	8.08056*	.66976	.000
	Non FFS	7.84722*	.66976	.000
Non FFS	FFS before	.23333	.66976	.935
	FFS after	-7.84722*	.66976	.000

n=540; *. The mean difference is significant at the 0.05 level.

4.3.10 Paired sample T-test

When the data (Table 31) for participants before and after FFS training was further subjected to the paired sample t-test, the results concurred with the ANOVA results shown in Table 33 above. The results in Table 34 show that there is a statistically significant difference in the level of productivity in the means of the FFS participants before and after the FFS training (t= -16.33, df=178, p=0.000).

Table 34

Mean production of maize per acre of FFS participants before and after participation

FFS Participants participation		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	T	Df	Sig.
Pair 1	Bags of maize before & (90kg Bags) of maize after FFS participation	-9.19143	7.44456	.56276	-16.333	178	.000

n=180

The results in Table 34 show that there is a statistically significant difference in the level of productivity in the means of the FFS participants before and after the FFS training (t= -16.33, df=178, p=0.000). These findings are consistent with (Davis *et al* 2010) where in their study found out that farmer field schooling had a significant impact on crop productivity in Kenya and Tanzania. They concluded that FFS participation had a significantly larger impact on crop productivity and also the value of crop productivity per acre for farmers participating in an FFS increased by about 80 percent and 23 percent in Kenya and Tanzania respectively. This demonstrates the FFSs approach effectiveness in increasing crop productivity.

4.4 Influence of Socio-Economic Factors on the level of practice of S&CMTs by FFS and NFFS Paerticipants

The fifth objective was "To determine the influence of socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) on the level of practice of Soil and Crop Management Technologies, promoted through FFS approach". The results were as follows:

4.4.1 Influence of attitude on the level of practice of S&CMTs-FFSs

The FFS participants had a higher mean attitude (4.45±0.03) than the non-participants (3.91±0.07) that is; the participants perceived that the FFS had a greater impact in improving the farming systems than the no-participants did (Table 35).

Table 35

Influence of attitude on the level of practice of SCMT FFS approach

FFS Participation	n	Mean	Std. Deviation	Std. Error of Mean
Participant	180	4.4500	.45850	.03417
Non-participant	180	3.9142	.95730	.07135
Total	360	4.1821	.79608	.04196

Key: n = 360

4.4.2 Gender roles in relation to the Implementation of S&CMTs by FFS Participants

When gender roles for the different sexes were compared it was found that the percentage of females playing a moderate to larger role in the overall implementation of all S&MTs was higher than that of males. The results are presented in Table 36.

Table 36

Gender roles in relation to the Implementation of SCMTs by FFS Participants

	Role of males		**Role of females**	
Rank	**Frequency**	**Percent**	**Frequency**	**Percent**
No role	5	1.4	2	.6
Small role	47	13.1	20	5.6
Moderate role	280	77.8	299	83.1
Large role	28	7.8	39	10.8
Total	**360**	**100.0**	**360**	**100.0**

N= 360

The results in Table 36 indicate that females who reported playing moderate role in the overall implementation soil and crop management technologies promoted through FFS were 83.1 percent as compared to 77.8 percent of males. Further comparing who played the large role between the females and males, the results in the Table indicated 10.8 percent of females as compared to 7.8 percent of the males. The overall results by combining the moderate and large roles, Females involvement in S&CMTs implementation was still higher at 93.9 percent as compared to 85.6 percent for the males.

4.4.3 Comparison of gender roles between FFS and Non-FFS on the level of practice of FFS promoted S&CMTs

A mean score was calculated to represent the roles of males and females in the various S&CMTs and agricultural and domestic activities on their farms. The results presented in Table 37

Table 37

Test of differences in gender roles between FFS and Non-FFS on the level of practice of SCMTs promoted through FFS approach

Gender	FFS (N=180)	Non FFS (N=180)	N	T	Df	P
	Mean ± SEM	Mean ± SEM				
Males	2.31 ± 0.059	2.41 ± 0.059	360	-1.262	358	.208
Females	2.58 ± 0.053	2.45 ± 0.056	360	1.647	358	100

n = 360

The findings in Table 37 indicate that, the role of females (2.58 ± 0.053) was larger than that of males (2.31 ± 0.059). In comparing between the FFS and the non-FFS, there was no significant difference between the FFS males and non FFS males (t=-1.262, d.f. =358, p=0.208). Similarly there was no significant difference between the score of FFS females and Non-FFS. However FFS males had a lower score than non-FFS males.

4.4.4 Gender roles in relation to the level of practice of S&CMTs promoted through FFS approach

The researcher investigated cases where each gender played a greater role than the other. Results are presented in Table 38.

Table 38

Gender role in relation to the level of practice of SCMT of FFS participants

Males		Equal share	Females	
Mostly	**Slight majority**		**Mostly**	**Slight majority**
Bush-clearing/land preparation	Compost making/FYM management	Planting	Weeding	Milking cows
Purchases of farm inputs	Feeding/Herding livestock		Watering crops/small irrigation	Collection of firewood
Pest control/ITK	Marketing of farm produce		Harvesting of crops	Cooking food
Soil conservation measures	Sale of land			Fetching water for domestic use
Farm income expenditure	Crop/Livestock sales			Caring of young children
Purchasing of farm implements	Tree planting			

The findings in Table 38 indicate that the activities that were mostly done by males were six as compared to only three activities that are mostly done by females. In the slight majority columns in Table 38 showing which gender between males and female in farm activity undertaking, both males and females undertook five activities each. Slight majority of males undertook compost making, feeding and herding livestock, and marketing of farm produce, sale of land, crops and tree planting. While slight majority of females undertook milking of cows, collecting of firewood, cooking food for the family, fetching water for domestic use and caring of young children. Only one activity was equally shared, planting of crops. In all activities that involved money, the male took the lead whereas most of the activities where females took the lead were in those related to domestic activities and housework.

4.4.5 Gender roles in agricultural and domestic activities

The gender roles were taken in the research to mean the division of labour of agricultural and domestic/household activities between males and females. The instrument designed to measure sharing of roles with respect to their gender is shown in appendix A Section C page 143 containing 21 activities sub-divided into agricultural and domestic activities. A comparative analysis was carried out between FFS and non-FFS respondents with respect to gender roles in these activities. It was anticipated that their gender roles would influence the adoption and impact of S&CMTs on their existing farming practices among the small-scale farmers in the study locations of the North Rift, Kenya. The results on gender roles are presented in Table 39.

Table 39

Gender roles in agricultural and domestic household activities of FFS and NFFS Participants

Activity	FFS farmers (n= 180) Percent		NFFS -farmers (n= 180) Percent	
	Male	**Female**	**Male**	**Female**
(A) Agricultural Activities				
(i) Common agricultural practices				
Bush-clearing/land preparation	79.4	20.6	86.2	13.8
Purchases of farm inputs	73.6	26.4	74.5	25.5
Compost making/FYM management	56.2	43.8	55.0	45.0
Planting	49.4	50.6	51.4	48.6
Weeding	48.6	51.4	49.3	50.7
Pest control/ITK	67.0	33.0	66.0	34.0
Watering crops/small irrigation	49.8	50.2	48.8	51.2
Harvesting of crops	47.1	52.9	48.9	51.1
Feeding/Herding livestock	52.7	47.3	55.0	45.0
Milking cows	22.5	77.5	28.0	72.0
Marketing of farm produce	53.2.	46.8	55.9	44.1
Means for common agricultural practices	**54.6**	**45.4**	**56.3**	**43.7**
(ii) Decision making about:				
Soil conservation measure	69.7	30.3	72.2	27.8
Farm income expenditure	61.2	38.8	65.7	34.3
Sale of land	56.2	43.8	62.1	37.9
Purchasing of farm implements	63.4	36.6	67.5	32.5
Crop/Livestock sales	59.1	40.9	65.7	34.3
Tree planting	59.4	40.6	64.6	35.4
Mean total on farmers' decision making	**61.5**	**38.5**	**66.3**	**33.7**
(B) Domestic activities				
Collection of firewood	6.1	93.9	8.8	91.2
Cooking food	3.7	96.3	5.5	94.5
Fetching domestic water	5.3	94.7	4.6	95.4
Caring of young children	10.4	89.6	8.4	91.6
Mean total for domestic activities	**6.4**	**93.6**	**6.8**	**93.2**

The results in the Table 39 reveal that both FFS and non FFS female respondents contributed more in physical farm activities except in bush clearing (79.4 percent), purchase of farm inputs (73.6 percent), pest control through spraying or use of ITK (67 percent), compost making (56.2 percent) for FFS males while NFFS (55.0 %) and feeding//herding livestock for all FFS males respondents where males participated more.

Milking of cows can be categorized as a female activity since the results show that FFS females contributed more than 77.5 percent and 72.0 percent as compared to their male's counterpart contribution of 22.5% and 28% for FFS and NFFS respectively.

Further the results in Table 39 reveal that in decision making pertaining to agricultural activities males played a major role compared to females for both FFS and non-FFS respondents. In contrast, females played a major role in domestic activities compared to males. For example in firewood collection, FFS and NFFS females contributed 93.9 percent and 91.2 percent respectively compared to the males who contributed 6.1 percent and 8.8 percent respectively. Overall results revealed that, females in the FFS and NFFS categories contributed (93.6 percent) and (93.2 percent) respectively to domestic activities. Both genders almost played equal role in common agricultural practices males contributing slightly higher with a mean of 54.6 percent and 45.4 percent for FFS and NFF males as compared to 45.4 percent and 43.7 percent for females respectively. Males on the other hand contributed (61.5 percent) and (66.3 percent) to the decision making in agricultural activities among FFS and NFFS respectively. Lionberger, (1996) observed that most homes are managed by women, as men are away in towns in search for jobs. There is a belief in some communities that domestic activities such as childcare, cooking and fetching water are culturally viewed as a woman's role.

4.4.6 Age Categories between the FFS and NFFS Participants

The age composition for participants was similar with that of non-participants with distribution across the categories being comparable. The results are presented in Table 40

Table 40

Distribution of Farmers by age in study locations

	FFS		**NFFS**	
Age	Frequency	Valid Percent	Frequency	Valid Percent
20-30	4	2.3	6	3.4
30-40	30	17.5	42	24.1
40-50	58	33.9	53	30.5
50-60	44	25.7	53	30.5
60-70	30	17.5	19	10.9
70-80	4	2.3	1	0.6
>80	1	0.6	0	0.0
Total	**171**	**100.0**	**174**	**100.0**

The results in Table 40 indicate that 33.9 percent of the FFS respondents were of the age category of 40-50 while Non FFS were 30.5 percent in the same category. In the 50-60 years age category was 25.7 percent for FFS and 30.5 percent for Non FFS farmers. In the youthful farmer age category of 20- 30 years only 2.3 percent for FFS and only 5.4 percent for Non FFS farmers. Therefore most of the farmers were between the age of 40-60 where 61.6 percent were FFS farmers and 61.0 percent was the Non FFS farmers. Adoption, impact and practice of agricultural technologies such as S&CM technologies are dependent on the age set of the farmers. According to Wasula (2000) and Lionberger (1996) they both found out that in a normal situation, older farmers are less inclined to adoption of farm practice(s) than younger farmers. Highest adoption of agricultural practices is found in the middle age consisting of farmers with ages ranging from 40 to 50 years.

In the case of the North Rift, Farmer Field Schools, age was not a strong factor in predicting the adoption, practice and subsequent impact of S&CMTs, as seen in the empirical analysis of socio-economic factors through regression model as shown in Table 43 on page 114. The reasons for such findings could be due to the fact that one of the FFS principles of training was the advocacy of equality and democratic participation in the FFS processes irrespective of age. For example through interaction of the researcher with FFS farmers in their training sessions, it was observed that even older farmers could articulate the AESA issues like presentations of sub group data to a large group indicating that age was not a limiting factor. Also the FFS training forums, co-operative approaches were encouraged, where the FFS participants invest in collaborative group learning, where each person's experience of reality was unique and their views, irrespective of age, were incorporated into the menu of trying to solve problems (Bunyatta et al 2004) Therefore, the season long FFS training ensured a close communication and interaction of farmers irrespective of age, gender and level of education. These interactions brought the FFS participants to almost the same plane of thinking.

4.4.7 Income of the Respondents

The income of the participants from farming was much higher than that of non-participants. The mean income from farming of participants was 109,504.49±11,167.9 while that of non-participants was 81,853.21±8,031.83 (Table 41)

Table 41

Mean income from farming between FFS and NFFS Participants in North Rift, Kenya

Respondent	N	Mean	Std. Error
FFS Participants	180	109504.4889	11167.90501
Non FFS Participants	180	81853.2056	8031.83151

4.4.8 Farm size

The researcher established the farm size for each respondent and the results are presented in Table 42.

Table 42

Distribution of farmers by farm size in hectares in Study locations of the North Rift, Kenya

Range (land size)	Frequency			Percent		
(Ha)	FFS	NFFS	Both	FFS	NFFS	Both
<= 4	111	133	244	61.6	73.9	67.8
4 – 8	39	27	66	21.7	15.0	18.3
8 – 12	9	8	17	5.0	4.4	4.7
12 – 16	5	5	10	2.8	2.8	2.8
> 16	16	7	23	8.9	3.9	6.4
Total	180	180	360	100	100	100

(Mean farm sizes 0.7630 ha)

The results in Table 42 indicate that most of the farms in the study area are small, with the majority of the respondents (61.6 percent), for the FFS participants and 73.9 percent for the non-FFS participants had land sizes less than or equal to 4 ha (Table 42). Results in the table further indicate that 21.7 percent of the FFs and 15.0 percent of the Non FFS participants had their land sizes of (4-8) hectares category. These indicate that the average farm size for both FFS and non-FFS households are small units which mean that most of the farmers are smallholder farmers. Their averagee farm sizes were 0.7630 hectares. These indicate that the average farm size for both FFS and non-FFS households are small units. Both the FFS and NFFS households 67.8 percent have less than 4 hectares of farm holdings, while only 6.4 percent have more than 16 hectares of land. . The land continues to be subdivided as the population also grows. Therefore small farm units would mean high competition for the newly introduced technologies with the existing farm practices. This means that there was a likelihood of the technologies which require bigger land sizes, for example the soil conservation structures and napier grass not being adopted. High value enterprises, which require small plots, for example, vegetables, poultry and zero grazing are likely to be adopted.

4.5 Test of Hypothesis Five to Determine the Influence of the Socio-Economic Factors on the Impact of S&CMTs

Hypothesis five stated: **Ho_5** There is no statistically significant influence of selected socio-economic factors (attitude towards change of existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) of the FFS participants and Non FFS participants on the impact of S&CMTs promoted through FFS approach in the North Rift, Kenya.

The fifth hypothesis was tested using the multiple regression model. The regression model is a predictive tool that was used to determine the influence of the identified socio-economic factors on the impact of soil and crop management technologies. The selected socio-economic factors analysed through the multiple regression model were attitude towards change of farmers existing farming system, gender role of respondents in participation in agricultural and domestic household activities, household income, farm size, age of farmer and level of education (number of years spent in school) of the FFS participants and Non FFS participants on the impact of Soil and Crop Management Technologies promoted through FFS approach in the North Rift, Kenya.

Multiple regression analysis was used to determine the contribution of each independent variable. In the analysis, the linear model was used to estimate the line of best fit and the significance of β coefficient of the independent variables was tested at α level of 0.05. The square of correlation coefficient ($R^{2)}$ was used to show the percentage of the total variations of the dependent variable that are explained by the addition of the independent variables in the model. High R^2 was most important since the model aimed at predicting future impact of agricultural technologies such as the Soil and Crop Management Technologies in relation to the socio-economic factors analysed in this study. As such, a significant improvement in goodness of fit showed that the variables were important in explaining the relationship. The results are presented in Table 43.

Table 43

Multiple Regression Analysis of Socio-economic Factors on Impact of S&CMFFSs

Model n =360	**R^2 Square**	**Beta**	**t-value**	**Sign**
Dependent variable:				
Impact of S&CM technologies				
(Constant)			2.037	.043
Age		-.026	-.632	.528
Household size		-.058	-1.525	.128
Years in school		.033	.817	.414
FFS Participation		-.711	-18.160	.000
Farm size		.024	.489	.625
Household income		.106	2.065	.040
Attitude toward FFS		.037	.915	.361
Mean role of females		.187	1.522	.129
Mean role of males		.309	2.485	.013
R^2 squared	**0.576**			
F=50.024	**p<0.000**	**Adjusted R^2=0.576**		

The results in Table 43 indicate that 57.6 percent (adjusted R^2=0.576) of the variation in the dependent variable (Impact of soil and crop management technologies) is explained by the independent variables in the multiple regression equation. From the results the explanatory variables, which contributed highly to the variation in the dependent variable were household income and farmers participation in the FFS-training and gender role. In the other hand, attitude towards change of their existing farming system, gender role of respondents in participation in agricultural and domestic household activities and level of education (years spent in school) were of moderate importance in contributing to the variation in the dependent variable. Further scrutiny of results in Table 43 indicated that age of respondents, farm size and household size were of less significance in contributing to the variation in the dependent variable. The results in Table 4 further indicate that contribution of the independent variables was significant ($F = 50.024$, $R^2=0.576$, $P <0.000$). This means that the model is a useful tool in making predictions about the influence of the independent variables on the dependent variable, and as such it can be used to assist in making informed decisions about the useful variables to be considered in promoting S&CMT in similar or different situations.

In this study a number of independent variables were expected to simultaneously contribute or influence the dependent variable. The dependent variable of yield of maize was used as an indicator of impact as a result of the dissemination of S&CMTs disseminated through FFSs in the locations of the study. The independent variables studied in the model were attitude towards change of farmers existing farming system, gender role of respondents in participation in agricultural and domestic household activities, household income, farm size, age of farmer and number of years spent in school. According to Mondal (2014) noted that the adoption behaviour of farmers (dependent variable) is likely to be affected by their farm size, knowledge, attitude, risk orientation, level of aspiration, media participation among others termed (independent variables). Modal (2014) further stated that it is of immense practical value to to know the extent to which the independent variable, separately or jointly could predictor contribute towards the dependent variable. This is done by computing multiple correlation and multiple regression.

A multiple correlation coefficient measures the combined relation between a dependent and a series of independent variables. Modal (2014) further stated that: If y is the dependent variable and x_1, x_2......are the independent variables, then the multiple regression equation will be: $Y= \beta_0+ \beta_1 X_1+ \beta_2 x_2$ ......

Where: β_0 is a constant and $\beta1 + \beta_2$ .... are referred to as Beta in Table 43 and are the partial regression coefficients.

The square root of the ratio of the regression sum of total squares is known as multiple correlation coefficient and is denoted *R*. It is always positive and less than one. The square of the multiple correlation coefficient R^2 represent the fraction of the variation in y, accounted for by its joint association with the variates x_1, x_2....... The coefficient is therefore a measure of the joint association of all these variates with the dependent variate y, and tells us how much of variation in y could be accounted for by reference to these variates (Mondal, 2014). The value of R^2 is generally multiplied by 100 and expressed in terms of percentage. In this study the multiple regression was generate as follows: $Y = \beta_0+ \beta_1 X_1+ \beta_2 x_2 + \beta_3 x_3+ \beta_4 x_4 + \beta_5 x_5+ \beta_6 x_6+ \beta_7 x_7+ \beta_8 x_8+ \beta_9 x_9+ \mu$

Where: Y is the dependent variable, while X_1, X_2.......X_9 are the independent variables

The definition of variables formulated for the model was as follows:

Y= yield of maize per unit area (ha or acres);

β_0 = is a Constant term and β_1, β_2...... β_9 = are the partial regression coefficients

μ = error term

X1 = Age of the respondents; X2 = Household size; X3 = Years in school; X4 = FFS Participation; X5 = Farm size

X_6 = Household income; X7 = Attitude of farmers toward FFS implementation;

X_8 = Mean role of females in agricultural and domestic activities and X9 = Mean role of males in agricultural and domestic activities.

The results of the regression analysis is presented in Table 43 and it gave the multiple regression equation as it was substituted in the multiple regression equation $Y = \beta_0+ \beta_1 X_1+ \beta_2 x_2 + \beta_3 x_3+ \beta_4 x_4 + \beta_5 x_5+ \beta_6 x_6+ \beta_7 x_7+ \beta_8 x_8+ \beta_9 x_9+ \mu$ to: Formulated multiple regression equation as per the substitution of the equation above was given :

$y = 2.037 - 0.026x_{1} - 0.058x_2 + 0.033x_3 - 0.711x_4 + 0.024x_5+ 0{,}106x_6+ 0.037x_7+ 0.187x_8+ 0.30_9x_9 + \mu$

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study. The objectives and premise of the study are discussed according to the findings of the study. It presents the introductory part to the study, literature review, the research design, the population and describes sampling procedures that were used in the study as well as development and administration of the instruments, data collection and analytical procedures. The final part is the summary of the findings, conclusions and recommendations. These findings and recommendations are important since is here where the implications for the upscaling of the Farmer Field School approach among the small scale farmers in Kenya are drawn. Suggestions for further research based on the gaps identified in the study concluded the chapter.

The Farmer Field School as a participatory extension approach was first introduced in Asia in 1989, with the main objective of controlling pests in rice fields. Its success has been registered specifically in Philippines and Indonesia as a national policy for transmitting knowledge on sustainable agriculture practices to the farmers.

In Kenya, the FFS was introduced in 1996 by FAO with the main aim of improving food security for the small-scale resource poor farmers. The main objective of the introduction of FFS as an alternative extension method besides the conventional extension approaches was to sharpen farmers' knowledge and skills through season-long FFS training on farmers' demand driven technology. Therefore, the implementation of FFS training methodology as one of the component of NAEP may be successful in enhancing agricultural productivity among the small scale farmers.

5.2 Summary of the Study

The study sought to establish whether the Soil and Crop Management Technologies promoted through FFSs had created any positive impact on the farming system and productivity among the smallholder farmers in North Rift region of Kenya. The main objective of FFS was to improve efficiency and effectiveness in agricultural productivity through investment in farmers' education through training as compared to the existing conventional extension approaches. The ultimate goal of FFS approach is to make farmers ‘experts’ in their own fields while maintaining the agro-ecosystem within their farms.

The purpose of the study was to determine the impact of the Soil and Crop Management technologies promoted through farmer field school approach on the farming system and productivity among the smallholder farmers in North Rift region of Kenya. The study examined if there was any difference between the performance of FFS participants and Non FFS in order to determine the impact of the FFS approach as compared with the conventional extension approach. In many studies carried out on FFS projects globally, the findings have shown evidence of positive impact on rural communities and sustainable agricultural development leading to improved income and livelihoods. The livelihood outcomes, productivity and farming system impact expected from this study was reflected in: the level of household income, Level of knowledge and skills acquired in S&CMTs and its application on their own farming systems hence become part of their farming practices. In the long term a positive impact is achieved in farmers’ fields, with impact implying both qualitative improvement of farmers’ livelihoods and improved soil fertility and crop management thus reflected in improved crop productivity. This will ensure food availability and accessibility hence achievement of household food security.

The literature review was mainly concerned with the topics relevant to the study. This included the concepts of dissemination, communication, participatory technological development, transfer and adoption, practicing of soil and crop management technologies. The aim of the literature review was to understand the concepts of related to the study. The theories relating to FFS approach as a participatory extension approach were reviewed. The conceptualization and understanding of the theories related to this study was important. These theories were interpreted to fit into learning process in the FFS setting and relating them to reality. The literature review was based on FFS approach. The Study was mainly concerned with dissemination, adoption and impact of soil and crop management technologies promoted through FFS approach in the North Rift, Kenya. The main independent variable in the framework was the impact of soil and crop management technologies disseminated through FFS training offered to FFS participants.

The FFS participants are expected to be disseminating the soil and crop management technologies to non-FFS participants through informal interactions thus causing an impact on their farming system. Another means of dissemination is through organized field days and demonstrations open to all the farmers within the locations and the neighbourhood where Farmer Field schools were established. Dissemination of the soil and crop management technologies through farmer to farmer extension is expected and hence its diffusion through the "snowball effect" is anticipated to occur. The FFS approach targeted farmers' groups for training, and after graduation, they are expected to have acquired knowledge, utilize and disseminate the agricultural technologies acquired to other farmers. Therefore the knowledge, adoption and practice of Soil and Crop Management technologies could be enhanced for both the FFS participants and Non FFS participants. The findings of this study have shown a positive impact of the S&CM Technologies on knowledge, productivity and farming system of the FFS and Non FFS farmers in the study location in the North Rift, Kenya.

5.3 Conclusions

Based on the finding of the study, a number of conclusions are drawn as follows:

(i) Farmer Field School participants scored higher in knowledge test questions. By subjecting the results of the common knowledge test to the t-test, the mean scores between the FFS and Non-FFS participants showed a significant difference. It was concluded that farmers who were exposed to soil and crop management technologies through season long training under FFS had acquired more knowledge than the non FFS farmers. The FFS participants were therefore better off in terms of knowledge acquired in S&CM technologies and had a higher level of understanding in these technologies than the Non FFS farmers. Therefore it was concluded that a greater impact of S&CM technologies on the farming system of the FFS Participants than that of the Non-FFS participants in the study locations of the North Rift Valley in Kenya.

(ii) The main objective was the determination of the level of impact of the Soil and Crop Management technologies promoted through FFSs approach on farming system (farm practices related to maize, vegetable and fodder production) of FFS participants before and after participating in FFSs in North Rift of Kenya.

From the findings, there was a statistically significant difference between FFS participants before and after participation in FFSs on the Farming System as result of the impact of S&CM technologies promoted through FFSs at ($P < 0.05$). Therefore it was concluded that FFS participation by small scale farmers as oppose to non FFS participation had a positive impact on their farming system. Therefore participation of farmers in FFSs brought a positive change in their farming systems as a result of incorporation of the S&CM technologies into their farm practices. For example the farmers who participated in FFS training have adopted and incorporated S&CM technologies such as compost making, soil conservation measures such as the ‘’fanya juu” terracing among others on their farms.

(iii) The Soil and crop Management technologies disseminated through Farmer Field School approach was tested for its impact on productivity in terms of farm income between a farmers before FFS participation and after FFS participation. The findings from the study indicated that there was statistically significant difference between the FFS participants before and after participating in FFS in their level of income as a result of the impact of soil & crop management technologies promoted through FFS tested at ($P < 0.05$). Therefore it was concluded that farmers who participated in FFS earned farmers a higher income than before joining FFS and participating. From the findings, there was a clear difference between FFS participants after participating and practicing the S&CM technologies as compared to the same farmers before participating in the FFS training. Farmers improved crop yields and income after adopting and practicing the S&CM technologies disseminated through FFS training approach. Therefore farmers who participated in S&CM FFS training realized a greater impact on their farming system and productivity.

(iv) The null hypothesis four stated that: “There is no statistically significant difference between FFS participants before and after participation in FFSs and Non FFS farmers on their productivity in terms of the Level of production per unit area for maize as a result of the impact of S&CMFFS dissemination approach in North Rift Districts".

The mean of production of maize per unit area of three groups was compared using one way analysis of variance (ANOVA). The findings showed a statistically significant difference between the means of the three groups of FFS participants before and after attending the FFS training sessions and the Non FFS Participants. Therefore, it was concluded that there was a statistically significant difference in the means of the three groups. The ANOVA and the post hoc multiple comparison analysis findings showed that, the farmers who had undergone the FFS training produced about 19.86 bags per acre which equivalent to about 50 bags of maize per hectare. Further findings of the same farmers produced 12 bags of maize equivalent to 30 bags per hectare before undergoing the FFS training. On comparing the non-participants and the FFS participants before FFS training they produced about 12 bags of maize per acre. From this findings it showed clearly that when farmers are trained through FFS approach they produce an extra 7 bags of maize per acre. It can be concluded that FFS approach had a greater impact on maize productivity than the conventional extension approach. FFS is a more superior approach in enhancing the adoption and practice of soil and crop management technologies as it has been demonstrated in this study. This implies that FFS if adopted will make farmers harvest more maize thus becoming food secure and can earn extra income.

(v) Multiple regression analysis was used to determine the contribution of each independent variable. The regression model is a predictive tool to determine the influence of the identified socio-economic factors on the impact of soil and crop management technologies. In the analysis, the significance of β coefficient of the independent variables was tested at α level of 0.05. Linear model was used to estimate the line of best fit. Based on the results obtained from the multiple regression analysis, the conclusion is that household income and farmers participation in the FFS-training and weighted gender role of respondents in participation in agricultural and domestic household activities were the best predictors influencing the adoption, practice and hence the impact of soil & crop management technologies on farming system and productivity among small scale farmers. Therefore by empowering FFS groups, such as in the study locations of the North Rift, Kenya in terms of provision of financial assistance through a soft loan, and by disseminating relevant technologies such as S&CMTs through FFS approach, could offer long-term solution to the small-scale farmers in raising agricultural productivity. Gender mainstream in FFS activities such as training is also an important aspect in the overall achievement of agricultural productivity among small scale farmers. Other factors such as attitude towards change of their existing farming system and level of education (years spent in school) were of moderate importance in contributing to the variation in the dependent variable.

The initiation of FFSs in the North Rift has enabled farmers to work as groups and currently most the FFSs have registered as groups under the department of social services. The FFS approach was initiated as common interest groups based on crop enterprises. The FFS entrepreneurial approach brought in the concept of commercialization and most of the FFSs are currently engaged in income generating activities. The opening of the FFSs in the North Rift have enabled the groups to work together thus enhancing group cohesiveness in consistent with Mwagi's findings in Kisii Kenya (Mwagi, 2004). FFS groups could easily be reached by facilitators for either training on new technologies or post-FFS follow-up activities.

5.4 Recommendations

i. There is a need for expansion of FFS Approach from the cluster sub counties where they were initiated to a wider farming community. This can be achieved by training more facilitators as it was done in the Soil Management Project where a core team of researchers, extensionists and farmers underwent a Training of Trainers course on the FFS approach. The Ministry of Agriculture can adopt the same training as the SMP had done it.

ii. The original well-trained nucleus of facilitators who can be referred to as FFS Master trainers who have a good understanding of the concept and principles involved in running FFS effectively should be identified and retained by the Ministry of Agriculture and Kenya Agricultural and Livestock Research Organization.

iii. From the findings, FFS have created an impact in productivity and a positive change in farming system, it is recommended that training of more researchers, extensionists and farmers on FFS participatory approach should be considered.

iv. These FFS master trainers should form a pool of experts on training of trainers (TOT) of staff and farmer leaders and stakeholders.

v. There is need to scale up the FFS approach while maintaining quality through monitoring and evaluation which can be effectively implemented by the Ministry of Agriculture through a programme.

vi. Therefore, the SMP addressed the issue of the need of a strong starting phase for the initial FFS. The expansion of the FFS should have a strong backstopping or capacity building by the SMP initially trained facilitators.

vii. Implementation of FFSs should be demand driven by the farmers as opposed to being donor driven. The focus therefore should be on self-propelling FFSs in addressing the farmers' identified constraints and needs for the farmers. This can be implemented through private public partnerships arrangements between the public sector, farmer organizations and other development partners

viii. The core principles of FFS such as intensive training of farmers through a technology cycle should be incorporated into existing extension approaches and methodologies to make them more effective at reaching small scale farmers and hence creating positive impact in alleviating poverty. This could be done by the Ministry of Agriculture in collaboration with other stakeholders.

ix. Policy makers and practitioners should take a cautionary approach with FFS when using them as an approach where they are suited rather than applying them as a blanket approach for all agriculture technologies.

x. Opening up of more farmer-led-field schools is a strong tool for dissemination and diffusion of S&CM technologies amongst the small scale farmers. This can be done by the Ministry of Agriculture in collaboration with other partners through public private partnership

5.5 Suggestions for Further Research

i. The FFS impact study should be replicated to cover a wider geographical area and ecological zones. Also it is suggested that the study should widen to cover more agricultural technologies such as zero-grazing, cash crop (Coffee and cotton) and food crops (sweet potatoes and Irish potatoes) to further ascertain the effectiveness of FFS in dissemination, adoption and impact of the agricultural technologies.

ii. Diffusion of agricultural technologies through FFS approach should be investigated with the aim of ascertaining the methodology for adoption and integration in to the National extension programme.

iii. The main challenges that remain unanswered are the sustainability issues and cost effectiveness of the FFS methodology. Therefore, more research work is needed in the aforementioned areas.

iv. The post FFS and follow up activities were not considered in this research, therefore there is a need to look into the constraints faced in the implementation of FFSs as a main strategy of educating the farmers.

v. The suggestion is for the FFS programme(s) to appraise FFS basic concepts, principles and facilitation strategies. For example facilitator should have enough institutional and organizational support to enable them to work consistently and effectively.

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APPENDIX A

FARMERS (HOUSEHOLD INTERVIEW SCHEDULE)

Impact of Soil and Crop Management Farmer Field Schools on Farming Systems and Productivity among Smallholder Farmers in North Rift, Kenya

SECTION A

Farmers' personal characteristics

Fill in or circle appropriately

Date…………………………

Name of respondent:.. ……………………………………………………………

a) Farmers code number:…………………………………………………………….

b) Gender of respondent:…………………………………………………………….
Key: 1 = Male 2 = Female

c) i) Age of respondent in years……………………………………………………………

ii) Relationship of respondent to household head………………. ………………………

1. Self 2. Wife 3. Son 4. Daughter 5. Relative 6 Others (Specify)

iii) Household structure – No of household members……………………

Adults above 15 years………………………. Children……………………

d) Circle the educational level indicating the number of years spent at school:

d) Educational level No. of years spent at school: ……………

Educational level	Number of years taken at formal schooling							
1. Primary education	1	2	3	4	5	6	7	8
2. Secondary education	1	2	3	4	5			
3.College training (Tertiary)	1	2	3					
4. University education	1	2	3	4	5	6		

e) Were you a member of Farmer Field School? (1). Yes……. (2). No …….if no, go to g

f) If yes which FFS school attended: ……………………………………………….

Key: 1) Khuyetana 2) Busime 3) Bulala 4) Twendembele

5) Bihkolwa 6) Muteremko 7) Upendo 8) Mutua 9) Mwangaza*

10) Mawazo 11) Umoja-Hututu 12) Weonia 13) Kwanuzu 14) Motosiet Mwangaza 15) Samiko 16Jiokoe 17) Umoja-Kapsara 18) Miti Moja 19) Matekesi 20) Kamito 21) Kokwet 22) Taiit

g) Village…………………………………………………………….

Key: (1) Yuya 1 (2)Tembelela (3) Kenya seed) (4) Milimani

Economic factors

Farm size………………………………………………………….(Hectares)

Number of parcels if More than one:

i) ……………………………… ii) …………………………………………

Others…………………………………………………………….

Ownership of land (tenure system) …………………………………………………

Key: 1. Individual ownership with (Title deed) 2. Inheritance (Co-operative)
3. Communal 4. Leasehold 5. Tenant 6. Others (Specify)

Who manages the farm

Key : 1) Father (head of household) 2) Mother 3) Jointly managed (Husband, wife, son or daughter) 4) Son or daughter 5) Others specify

SECTION B

Farming characteristics

d) What are the main enterprises on your farm?

List them in order of decreasing importance.

Crop enterprises	**Hectare(s)**	**Livestock enterprises**	**Number(s)**
1. 2. 3. 4 5.		1. 2. 3. 4. 5.	

SECTION C

Socio-economic factors

a) Gender roles or division of labour of agricultural and household activities between male and female respondents**.**

Who in the household generally carry out the following activities (scores as per given key below).

Activity	Gender		
	Male=1	**Female=2**	**Both =1**
1. Bush-clearing/land preparation			
2. Purchases of farm inputs seeds/fertilizers/Dairy meal			
3. Compost making/FYM management			
4. Planting			
5. Weeding			
6. Pest control/ITK			
7. Watering crops/small irrigation			
8. Harvesting of crops			
9. Feeding/Herding livestock 10. Milking cows			
11. Marketing of farm produce (maize, beans and veg)			
12. Decision making on: i) Soil conservation measures			
ii) Farm income expenditure			
iii) Sale of land			
iv) Purchasing of farm implements			
v) Crop/Livestock sales			
vi) Tree planting.			
12. Collection of firewood			
13. Cooking food			
14. Fetching domestic water			
15. Caring of young children			

Key: Choose among the following three score boxes below with ratio of work between male and female and insert the scores as per the responses from every activity above.

	Male only		Female only		Both Male & Female	
	Male	Female	Male	Female	Male	Female
Scores	5	0	0	5	2	2

Economic factors

Income Received by the FFS and Non-FFS farmers.

Indicate the income category that best present your total earnings per month including that from supplementary sources. (Key provided below)

(i)What are your main sources of income and earnings?

SOURCE OF INCOME	**AMOUNT EARNED Kshs**	
	Monthly	**Yearly**
1. Farming		
Off-farm sources		
2. Salary from employment		
3. Small-scale business i.e. (Kiosks, Hotels, Shop, bar.		
4. Petty trade (hawking, sale of charcoal, illegal brews).		
5. Assistants by relatives/Lenders		
Others (specify)		
Total Annually		

b (ii) State how you spent your income on the following: - (Circle one only)

Expenditure	Income Expenditure				
Construction of soil conservation structure	1	2	3	4	5
Land preparation	1	2	3	4	5
Purchasing of farm inputs	1	2	3	4	5
Food for the household	1	2	3	4	5
School fees	1	2	3	4	5
Medical bills (Household maintenance)	1	2	3	4	5
Leisure	1	2	3	4	5
Others specify	1	2	3	4	5

Key: 1. Very low 2. Low 3. Moderate 4. High 5. Very High

<10% 10-30% 31-50% 51-70% >70

SECTION D

a) To determine and describe the impact of the Soil and Crop Management FFSs approach on farming system (farm practices related to maize, vegetable and fodder production) of FFS participants before and after participating in FFSs in North Rift of Kenya. **(Level of change in farm practices)**

Circle each option appropriately. Key 1 = None, 2 = Low, 3 = Medium, 4 = High, 5 = Very high

FFS-Soil and Crop management/Agricultural technologies (Before FFS training) and Non FFS farmers	Extent of practice Area under Technologies in (Ha, tonnes, Length (m)	Level of practice of SM&C Management technologies **(FFS participants before training**				
1. Compost making:						
Knows the making process		1	2	3	4	5
utilization on his/her farm		1	2	3	4	5
Sale of extra compost.		1	2	3	4	5
2. Soil conservation through:						
(i) Fanya juu /channel terrace		1	2	3	4	5
(ii) Grass strips		1	2	3	4	5
(ii) Contour farming		1	2	3	4	5
(v) On-farm tree planting		1	2	3	4	5
3. Improve pasture establishment on their farms:						
Napier grass establishment and management		1	2	3	4	5
Tumbukiza method for napier grass planting.		1	2	3	4	5
Planting of Rode grass/desmodium.		1	2	3	4	5
4. Vegetable growing						
(i) Nursery management		1	2	3	4	5
(ii) Transplanting		1	2	3	4	5
(iii) Pest and disease control		1	2	3	4	5
(iv) Harvesting and marketing		1	2	3	4	5
5. Growing of alternative legumes						
(i) Soyabeans		1	2	3	4	5
(ii) Dolicos lablab		1	2	3	4	5
(iii) Cowpeas		1	2	3	4	5
6. Use of plant extract (ITK) for control of insect						
pests in:		1	2	3	4	5
(i) Kales		1	2	3	4	5
(ii) Local vegetables i.e. "Sucha"		1	2	3	4	5
(iii) Maize						
7. On-farm experimentation/demonstrations i.e. Farmer-led research (FFS graduate/Non-FFS doing research)		1	2	3	4	5

8. Correct maize varieties for their area (AEZ): e.g. Hybrid 614, 628, 626, 625 or 511, 512, 513		1	2	3	4	5
9. Organic/Inorganic fertilizers (i) Maize Vegetables		1 1	2 2	3 3	4 4	5 5
10. Correct spacing for the following crops: i. Maize ii. Cabbages iii.Napier grass		 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5

b) To determine and compare the change in farm practices of FFS participants (before and after joining FFS) and non-FFS participants as a result of the impact of the S& M Technologies disseminated through FFS and extension training among smallholder farmers in North Rift.

Which of the following technologies learned through FFS/Extension have you adopted as part of your practice on your farm? , extent of practice of the new S&CMTs and rate the overall extent of practice on the individual farm.

Circle each option appropriately. Key 1 = None, 2 = Low, 3 = Medium, 4 = High, 5 = Very high

FFS-soil management/Agricultural technologies (After FFS training)	Extent of practice Area under Technologies in (Ha, tonnes, Length (m)	Level of change in farm practice as a result of introduction of FFS-S&CM technologies **(FFS participants after FFS training)**				
1. Compost making: Knows the making process utilization on his/her farm Sale of extra compost.		 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5
2. Soil conservation through: (i) Fanya juu /channel terrace (ii) Grass strips, (iii). Contour farming (v) On-farm tree planting		 1 1 1 1	 2 2 2 2	 3 3 3 3	 4 4 4 4	 5 5 5 5
3. Improve pasture establishment on their farms: (i) Napier grass establishment and management (ii) Tumbukiza method for napier grass planting. (v) Planting of Rode grass/desmodium.		 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5

4. Vegetable growing (i) Nursery management (ii) Transplanting (iii) Pest and disease control (iv) Harvesting and marketing		 1 1 1 1	 2 2 2 2	 3 3 3 3	 4 4 4 4	 5 5 5 5
Growing of alternative legumes (i) Soyabeans (ii) Dolicos lablab (iii) Cowpeas		 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5
Use of plant extract (ITK) for control of insect pests in: (i) Kales (ii) Local vegetables i.e. "Sucha" (iii) Maize		 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5
7. On-farm experimentation/demonstrations i.e. Farmer-led research (FFS graduate/Non-FFS doing research)		1	2	3	4	5
8. Correct maize varieties for their area (AEZ): e.g. Hybrid 614, 628, 626, 625 or 511, 512, 513		1	2	3	4	5
9. Organic/Inorganic fertilizers (i) Maize Vegetables		1 1	2 2	3 3	4 4	5 5
10. Correct spacing for the following crops: Maize Cabbages Napier grass		 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5

Circle each option appropriately. Key 1 = None, 2 = Low, 3 = Medium, 4 = High, 5 = Very high- Livelihood improvement.

Impact of S&CM FFS on productivity in terms of per unit area and income

Enterprise	**Production or yield per unit area (Productivity)**			
	Before FFS intervention No of Kg/bags/Kshs Farmer's practice (conventional)	After FFS intervention No of kg/bags (Use of fertilizers or tumbukiza method for Napier grass)	Increase/decrease No of kg/bags	(difference) %
Maize				
Income from maize				
Sucha veg.				
Income from sucha				
Kales veg.				

Income from Kales				
Napier Fodder				
Income from fodder				

To determine and compare the impact of Soil and Crop management FFS approach on productivity in terms of farm income related to maize, vegetables and fodder production of the FFS participants before and after participating in FFSs in North Rift of Kenya.

Level of impact on farm productivity as a result of dissemination of FFS-Soil &Crop management/Agricultural technologies for FFS Farmers (before FFS training) and After FFS Farmers.	Level of impact on farm productivity related to income as a result of use of S&CMTs (before FFS training)					Level of impact on farm productivity related to income as a result of use of S&CMTs (After FFS training)				
1. Compost making and utilization:	1	2	3	4	5	1	2	3	4	5
2. Soil conservation through:										
(i) Fanya juu /channel terrace	1	2	3	4	5	1	2	3	4	5
(ii) Grass strips	1	2	3	4	5	1	2	3	4	5
(iii) Contour farming	1	2	3	4	5	1	2	3	4	5
(iv) On-farm tree planting	1	2	3	4	5	1	2	3	4	5
3. Improve pasture establishment on:										
(i) Napier grass establishment and management	1	2	3	4	5	1	2	3	4	5
(ii) Tumbukiza method for napier grass planting.	1	2	3	4	5	1	2	3	4	5
(iii) Planting of Rode grass/desmodium.	1	2	3	4	5	1	2	3	4	5
4. Vegetable growing										
(i) Nursery management	1	2	3	4	5	1	2	3	4	5
(ii) Transplanting	1	2	3	4	5	1	2	3	4	5
(iii) Pest and disease control	1	2	3	4	5	1	2	3	4	5
(iv) Harvesting and marketing	1	2	3	4	5	1	2	3	4	5
Growing of alternative legumes e.g.										
(i) Soybean	1	2	3	4	5	1	2	3	4	5
(ii) Delicious lablab	1	2	3	4	5	1	2	3	4	5
(iii) Cowpeas	1	2	3	4	5	1	2	3	4	5

Use of plant extract (ITK) for control of insect pests in: (i) Kales (ii) Local vegetables i.e. “Sucha” (iii) Maize	1 1 1	2 2 2	3 3 3	4 4 4	5 5 5	1 1 1	2 2 2	3 3 3	4 4 4	5 5 5
Correct maize varieties for their area (AEZ): e.g. Hybrid 614, 628, 626, 625 or 511, 512, 513	1	2	3	4	5	1	2	3	4	5
9. Organic/Inorganic fertilizers (i) Maize (ii) Vegetables	1 1	2 2	3 3	4 4	5 5	1 1	2 2	3 3	4 4	5 5
10. Correct spacing for the following crops: (i) Maize (ii) Cabbages (iii) Napier grass	1 1 1	2 2 2	3 3 3	4 4 4	5 5 5	1 1 1	2 2 2	3 3 3	4 4 4	5 5 5

Rating scale of income explanations (1. no change in income 2.Very little change 3. Moderate chane 4.double income 5 Very high more than triple)

To determine and compare the impact of Soil and Crop Management FFS approach on productivity in terms of the Level of production per unit area for maize, vegetables and Napier grass of the FFS participants before and after participation in FFSs and non FFS participants in North Rift of Kenya.

Level of impact on farm productivity per unit area as a result of dissemination of FFS-Soil &Crop management/Agricultural technologies for FFS Farmers (before FFS training) and Non FFS Farmers.	Level of impact on farm productivity per unit area as a result of use of S&CMTs				
1. Compost making and utilization:	1	2	3	4	5
2. Soil conservation through: Fanya juu /channel terrace Grass strips (iii) Contour farming (iv) On-farm tree planting	 1 1 1 1	 2 2 2 2	 3 3 3 3	 4 4 4 4	 5 5 5 5
3. Improve pasture establishment on: (i) Napier grass establishment and management Tumbukiza method for napier grass planting. (iii) Planting of Rode grass/desmodium.	 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5

4. Vegetable growing (i) Nursery management (ii) Transplanting (iii) Pest and disease control (iv) Harvesting and marketing	 1 1 1 1	 2 2 2 2	 3 3 3 3	 4 4 4 4	 5 5 5 5
Growing of alternative legumes e.g. (i) Soybeans (ii) Delicious lablab (iii) Cowpeas	 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5
Use of plant extract (ITK) for control of insect pests in: (i) Kales (ii) Local vegetables i.e. "Sucha" (iii) Maize	 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5
8. Correct maize varieties for their area (AEZ): e.g. Hybrid 614, 628, 626, 625 or 511, 512, 513	1	2	3	4	5
9. Organic/Inorganic fertilizers (i) Maize (ii) Vegetables	1 1	2 2	3 3	4 4	5 5
10. Correct spacing for the following crops: (i) Maize (ii) Cabbages (iii) Napier grass	 1 1 1	 2 2 2	 3 3 3	 4 4 4	 5 5 5

Key: Rating scale for production per unit area explanations (1. no change in yield 2.Very little change in yield 3. Moderate change in yield for maize, vegetables and Napier grass 4.double yield for maize, vegetables and Napier grass 5 Very high more than triple yield for maize, vegetables and Napier grass)

To determine the influence of soil and crop management FFS approach on the selected socio-economic factors (attitude towards change of their existing farming system, gender participation, income level, farm size and farmer personal characteristics of age, level of education and sex) of the FFS participants and Non FFS participants in North Rift, Kenya.

Item	**SA**	**A**	**U**	**DA**	**SD**
1. FFS participation/Approach has created more impact than the normal extension teaching methods in the research sites e.g. (T&V)					
2. FFS. Does not answer my agricultural problems of lack of technical know-how					
3. FFS methodology is enjoyable it makes the farmer expert in his/her field or farm					
4. FFS has a great future prospects and impact for the farming community in terms of increased farm income as a result of adoption of SM technologies					
5. Attending FFS is of no consequence and no impact on farmers livelihoods.					
6. FFS is a forum for Researchers and well to do (wealthy) farmers who can afford to buy the inputs required					
7. FFS training increases farmer income and reduce costs					
8. If I did not attend the FFS training I would not have known much about soil management and good farm management practices.					
9. If it was not of FFS-training, being brought to our village we could not have formed a group and register it.					
10. FFS participation empowers the farmers in terms of experimentation and discovery-based learning					
11. FFS welcomes all farmers irrespective of gender, age to participate i.e. (It is democratic)					
12. The FFS facilitators are guides and not teachers					
13. FFS extension methodology empowers farmers in terms of decision making in relation to their farming activities					

14. FFS is a suitable extension methodologies since it respects the views of all the farmers irrespective of gender					
15. FFS participation has increased farmers networks and contacts with extension agents, NGO's and all interested partners (Built partnership)					
16. FFS – Soil management knowledge-intensive training didn't focus on soil management alone. They provide farmers the opportunity to learn other aspects of farming and non-farming aspects i.e. (public health care, family planning and Aids control).					
17. The FFS process from ground working, village immersion, Long season training through to graduation involves the farmers and in the long-run increase farmers knowledge i.e. (Effective knowledge dissemination tool)					
18. FFS encourages farmer to farmer communication/Extension.					
19. FFS approach encourages group formation and enhances economic welfare of their members. Improve agricultural productivity.					
20. Demonstrations/FFS trials plots are KARI/AGRIC activities we farmers are there to just learn from them (no ownership technologies).					

Instructions: For each statement chose from the following possible answers:

Key: 1) Strongly agree (SA) 2) Agree (A) 3) Uncertain/undecided (U) 4) Disagree (DA) 5) Strongly Disagree (SD)

Check (√) the column that you believe best represent your feelings about FFS implementation?

APPENDIX B

COMMON AGRICULTURAL KNOWLEDGE TEST

Instructions: Tick (√) appropriately the correct answer to the given statement.

Statement /Item	True	False
1. FFS is meant for all categories of farmers irrespective of age, gender and economic status.		
2. The procedure of making compost is that: you collect green leaves of plants mixed with dry leaves and bury in a pit and wait for it to decompose		
3. Compost is easy to make and it is mainly used for growing vegetables		
4. Agro-ecosystem analysis demonstrations is the "heart" of the FFS/EXT		
5. Every FFS/crop demonstration must have a study field/plot for farmer(s) to test and approve or reject a given technology e.g the soil management, Varietal trial.		
6. All insects are harmful to plants		
7. Terracing, Contour farming ,crop rotation and cut-off drain are all physical measures of soil conservation		
8. Soil is plant food		
9. Soil conservation increase agricultural yields in the long run		
10. Hybrid seed maize (H511, 512 and 513) varieties are suitable for Kitale area		
11. Control of weeds early in the season helps the development of the maize		
12. Stalkborer is a worst enemy of a bean plant as opposed maize		
13. Aphids seriously attack maize than beans during the dry spell		
14. Measurement of a vegetable nursery width should be 1meter to enable easy management. i.e. (Weed control, planting)		
15. "Karate" (insecticide)kills all insects irrespective of useful insects like bees and ladybirds		
16. Everytime we see insect in the maize fields or vegetable fields we		

should spray insecticides to make certain that we have a good crop yield.		
17. Higher plant density of maize will always result in higher yields.		
18. It is safe to mix and apply pesticide without wearing protective clothings		
19. For germination of maize and beans to occur we require moisture		
20. “Tumbukiza” is a method of planting napier grass for livestock feeds.		

(iii) To determine and compare the impact of the Soil and Crop Management FFSs approach on the knowledge and skills of the FFS participants and Non FFS Participants in North Rift of Kenya

Fill by: Rate the knowledge by circling only one using the key provided below.

Technology application on their farms	**Level of knowledge** (Non FFS farmers)					**Level of knowledge** (FFS Participants)				
1. Rate the level of use of high quality compost for maize/vegetables growing on your farm. (After FFS training)	1	2	3	4	5	1	2	3	4	
2. Mixing of farm yard manure and organic fertilizer at half rates for maize production.(After FFS training)	1	2	3	4	5	1	2	3	4	5
3. Soil conservation methods for control of soil erosion in maize/vegetables and pasture in their farms (contour, grass strips, Unploughed strips, terrace & COD). (After FFS training)	1	2	3	4	5	1	2	3	4	5
4. Legumes as a nitrogen fixing for improve soil fertility i.e. Beans, Soya beans, “Njahi” and cowpeas. (After FFS training)	1	2	3	4	5	1	2	3	4	5
5. Selection of maize varieties for the area i.e. the right hybrid seeds. (After FFS training)	1	2	3	4	5	1	2	3	4	5
6. Use of indigenous technical knowledge to identify and use plant extracts to control pests in vegetables and maize. (After FFS training)	1	2	3	4	5	1	2	3	4	5

7. Integration of fodder crops/improved pastures into farming system for livestock feed, improve soil fertility for increased milk productione. “Tumbukiza” for napier grass production. (After FFS training)	1	2	3	4	5	1	2	3	4	5
8. Special topics on (After FFS training):										
Poultry management	1	2	3	4	5	1	2	3	4	5
Vegetables growing	1	2	3	4	5	1	2	3	4	5
Others (specify)……………………………………	1	2	3	4	5	1	2	3	4	5
9. Leadership - organizational abilities (After FFS training)	1	2	3	4	5	1	2	3	4	5
10. Field observation through Agro-ecosystem analysis (AESA) or small plot/demonstration adaptability trial. (After FFS training)	1	2	3	4	5	1	2	3	4	5

Key: 1 = None 2 = Low 3 = Moderate 4 = High 5 = Very high

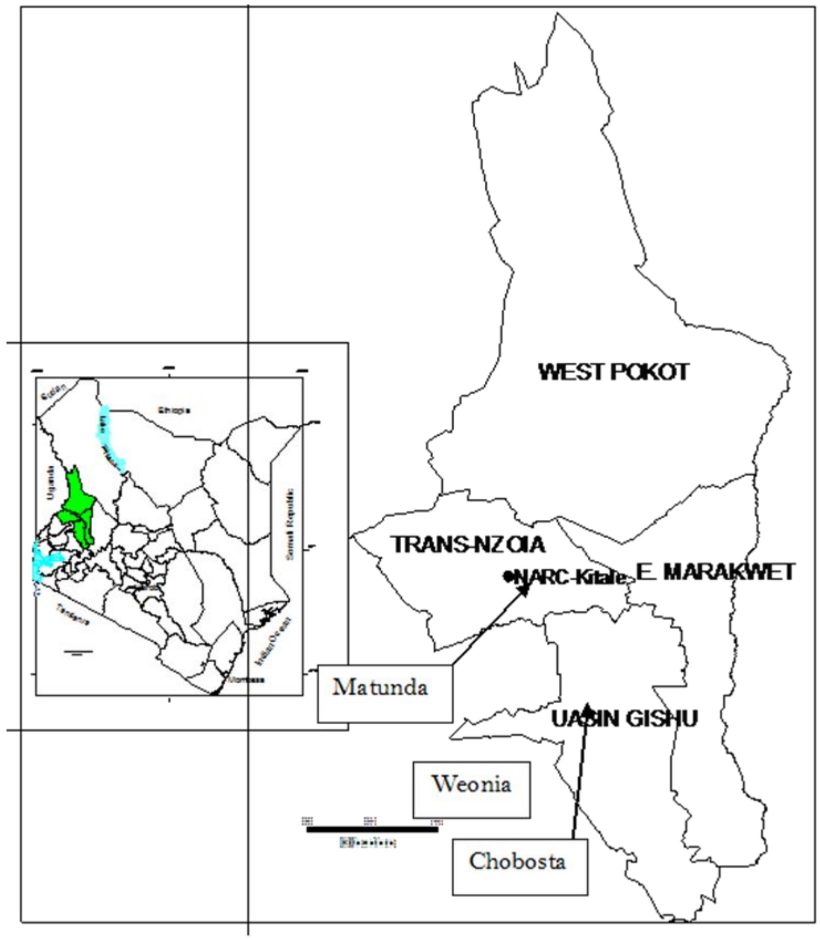
APPENDIX C

RESEARCH PERMIT

APPENDIX D

MAP OF STUDY AREA

The Study areas included: Yuya, Birbiret and Motosiet Locations of Kaplamai Division and Matunda location of Kimilili Ward of Trans-Nzoia County and Chebosta location in Kiplombe Ward of Uasin Gishu County where 8 and 14 FFSs were introduced respectively.



Map shows the Kenya Agricultural Research Institute’s (KARI), National Agriculture Research Centre-Kitale and its five mandate Districts then in 2001 (changed to Counties in 2010) in the North Rift Valley Region of Kenya, covering an area of 17180 km2 with a population of 2.101 million 1999 census and a population density of 122 persons per kilometer.