INFLUENCE OF FARMER FIELD SCHOOL EXTENSION APPROACH ON SMALLHOLDERS' KNOWLEDGE AND SKILLS OF DAIRY MANAGEMENT TECHNOLOGIES IN MOLO DIVISION, NAKURU DISTRICT OF KENYA

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A Thesis

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NJORO

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DECLARATION AND RECOMMENDATION

DECLARATION

I hereby declare that this is my original work and that it has not been presented in part or whole for an award of a degree or diploma in this or any other University.

Signature: ____________________ Date: ____________________

John Abuga Makori

RECOMMENDATION

This work has been submitted for examination with our recommendation as University supervisors.

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DEDICATION

This thesis is dedicated to my wife, Nyamoita, daughters, Jeliah Kerubo and Betty Moraa and son Obare for their prayers, patience and support while away in the University or in the Field undertaking research.

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ABSTRACT

Implementation of Farmer Field School (FFS) extension approach in disseminating knowledge and skills on management technologies for crop production, crop pests, soil and water conservation (CPSWC) has had proven successes. To replicate its successes, FFS was extended to smallholder dairy production as an alternative to the conventional extension approaches (NFFS) which had proved ineffective in disseminating knowledge and skills on dairy management technologies (DMTs). However many management aspects of CPSWC may not be applicable in dairy production. This raises the question as to whether the successes of FFS in CPSWC can be replicated successfully in disseminating DMTs to smallholders. This study assessed the influence FFS has had on farmers' knowledge and skills on DMTs in Molo division where FFS has been applied in smallholder dairying. A stratified random sampling cross-sectional survey conducted obtained participating farmers, 94 in FFS and 72 in NFFS. A structured questionnaire was used to collect data on knowledge and skills on aspects of DMTs, which included Artificial Insemination (AI), calf rearing, dairy cow feeding, control of mastitis, silage making and management of napier grass fodder. Knowledge was measured on ability to correctly answer a question on use aspect of DMTs from a set of 4-multiple choice answers. Farmers self-rated their skills in use aspects of DMTs on a 4-point Likert scale (1= least, 4= highly skilled). Hypothesis was tested that FFS and NFFS trained farmers were equally knowledgeable and skilled in the use of DMTs by fitting extension approach (FFS and NFFS) together with identified moderator variables as the independents and farmer's knowledge and skills as the dependent variables. Differences between FFS and NFFS for the proportion of farmers knowledgeable about DMTs were tested using Chi-square (χ^2) test while differences in skills was tested using non-parametric Mann-Whitney U test. Differences in realised dairy productivity levels were tested using t-test. All statistical tests were done at 5% level of significance using SPSS package. Compared to NFFS, the FFS trained farmers were more ($p<0.05$) knowledgeable and skilled on the use of DMTs and they achieved higher ($p<0.05$) milk yields and fewer ($p<0.05$) services per conception but body condition of their cows were not any better ($p>0.05$). These findings are valuable reference to extension agents, farmers, policy makers, extension delivery systems and researchers in the future design of effective dissemination approaches for DMTs targeting smallholders. It provides a basis for packaging of technologies for enhanced adoption by smallholder farmers.

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LIST OF ACRONYMS

AESA	Agro-ecosystem analysis
AI	Artificial Insemination
CBS	Central Bureau of Statistics
CRSP	Collaborative Research Support Programme
CPSWC	Crop production, Crop pests, Soil and Water Conservation Technologies
DFFS	Dairy Farmer Field Schools
DFID	Department for International Development
DLPO	District Livestock Production Officer
DMT	Dairy Management Technology
FAO	Food and Agriculture Organization
FASA	Focal Area Shifting Approach
FFS	Farmer Field School
FSR	Farming Systems Research
GoK	Government of Kenya
ILRI	International Livestock Research Institute
IPM	Integrated pest Management
ISWM	Integrated Soil and Water Management
KCC	Kenya Cooperative Creameries
MoARD	Ministry of Agriculture and Rural Development
MoLFD	Ministry of Livestock and Fisheries Development
NAEP	National Agricultural Extension Policy
NALEP	National Agriculture and Livestock Extension Programme
NDDP	National Dairy Development Project
NFFS	Non-Farmer Field School
NGO	Non-Governmental Organization
PTD	Participatory Technology Development
PTSM	Polythene Tube Silage Making
SANREM	Sustainable Agriculture and Natural Resources Management
SPSS	Statistical Package for Social Sciences
T&V	Training and Visit.
ToT	Transfer of Technology

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Agricultural extension is an important service for agricultural development in countries whose economies are driven by agriculture (Oladele, 2001). In such countries, agricultural extension services face constant pressure to use extension approaches that are effective in disseminating technologies to farmers. Effective extension approach enhances farmers' knowledge and skills necessary for using the technology. One way to identify an effective extension approach is to assess the knowledge gained by farmers about the technologies disseminated and the skills acquired by farmers in using those technologies. In Kenya, where the economy is agriculture driven, the Government has expressed concern in a policy paper "Strategy for Revitalizing Agriculture" that there is no credible extension approach in place and that messages delivered to farmers lack new and useful information to enhance increased productivity (MoA & MoLFD, 2004). Although the extension service has used a variety of approaches in the past, the use of the available agricultural technologies by smallholder farmers remain limited (ILRI, 2002; MoA & MoLFD, 2004). The limited use of agricultural technologies is considered a contributing factor to low agricultural productivity in the smallholder farming systems (SANREM CRSP, 2003).

Several extension approaches developed have been put into use since the 1950s, in search of approaches that enhance effective dissemination of agricultural technologies to farmers in order that they increase their agricultural productivity (Byerlee *et al*., 1982). In the 1950s to 1960s, the dominant extension approach was the Transfer of Technologies (ToT) that was developed in research centres. This approach was mainly regulatory with some level of coercion and emphasis was on adoption and non-adoption of technologies without regard to how knowledge and skills about using the technologies was acquired. Since farmers largely failed to adopt new technologies through ToT, a new approach the Farming Systems Research (FSR) was introduced in the 1970s. FSR focused on on-farm testing and refining of technologies but also could not effectively address the multiple and often diverse needs of farmers.

To correct for the weaknesses of the ToT and FSR, a new extension approach of Training and

Visit (T&V) was introduced in the 1980s to strengthen feedback in the transfer of information and technology from research via the frontline extension workers and contact farmers to the general farming community. T&V however used poor channels of communication between researchers and farmers and could not address the varying needs of heterogeneous groups of farmers with single technological package approach. The ToT, FSR and T&V comprise conventional extension approaches (NFFS) characterized by regulatory, advisory or educational approach with top down and non-participatory features. These approaches could not enhance the uptake of technologies to farmers particularly the smallholders (ILRI, 2002). The declining government support for the NFFS extension approaches for their ineffectiveness in disseminating technological innovations to farmers has prompted a need for alternative methods of disseminating technologies (Moris, 1991; Scarborough *et al.* 1997; Wambugu 1999). To improve the situation, new extension approaches were developed and include the Focal Area Shifting Approach (FASA) and the Farmer Field School (FFS) extension approach. The FFS uses participatory methods in enhancing farmers` knowledge and skills in the use of the agricultural technologies.

With the FFS, extension agents play facilitating role to a group of farmers in the field by involving them in interactive learning and field experimentation. This participatory approach is meant to help farmers develop individual analytical skills, critical thinking, creativity and capacity for independent problem solving. FFS adopts an integrated curriculum in which farmers generate learning materials. The FFS participatory approach is designed to empower farmers with knowledge and skills about technologies with the aim of increasing adoption rates and subsequently improving agricultural productivity (Van de Fliert, 1993). The application of FFS in extension was first introduced in East Asia in the late 1980s for intensive dissemination of technology on integrated pest management practices in rice (Leeuwis *et al.*, 1998). Impact studies have shown that FFS participation significantly enhanced farmers` knowledge and skills about the technologies disseminated. Following its success in rice, FFS was extended to other crops and diseases across Asia, Latin America and Africa (Nelson *et al.,* 2001).

In Kenya, Food and Agriculture Organization of the United Nations (FAO) introduced FFS in 1995 in the integrated management of crop pests (IPM), integrated soil and water management (ISWM) practices. Presently, more than 1000 FFS in Kenya are based on IPM and ISWM (Minjauw *et al*, 2003). The success of FFS in crops and soil and water management motivated its extension to smallholder dairy production, which accounts for over 60% of the total domestic milk production and 70% of all the marketed milk (Omore *et al.*, 1999; Bebe *et al.*, 2002). With the support of DFID/FAO, ILRI introduced the FFS extension approach to smallholder dairy farmers in Molo division in 2001 and other parts of Rift Valley and Central province to replicate its success in enhancing knowledge and skills of dairy management technologies (DMTs) (Minjauw *et al.*, 2002). Currently there are six dairy FFS operating independently in different locations of Molo division. The DMTs involved are calf rearing, artificial insemination (A.I), dairy cow feeding, mastitis control, napier fodder management, polythene tube silage making and napier fodder management. Table 1 presents some of the characteristic differences between dairy and crop enterprises.

Table 1: Characteristic differences between crop and dairy enterprises

Dairy enterprise	Crop enterprise
Responses to treatment are generally long term and cannot necessarily be pegged on calendar season	Responses to treatment pegged on seasonality and take a relatively short period
High economic values of animals do not permit experiments that might involve some risks or short term losses in productivity	Low economic value of crops allows for experimentation that might involve some risks or short term losses in productivity
High costs of implementing some experimentation e.g. comparing ECF disease incidence in immunised and non immunised animals	Relatively low costs of performing experimentation.

The FFS used in smallholder dairying has wholesomely adapted agronomic curriculum developed for crops, integrated pest management (IPM), soil and water management to dairy enterprise However, many aspects of dairy management are not similar to those needed in crops, pests, soil and water conservation (Table 1). The level of investment in dairy is higher but a slow return than is in crop production. Schmidt (1997) observed that responses to animal health and reproductive interventions are of longer term and thus may not require adapting single season cycles, as is the case with crops. Schmidt further indicated that dairy animal health, fertility and nutrition are both quantitatively and qualitatively more complex relative to crops, which necessitates the need to assess the influence of FFS in enhancing knowledge and skills of farmers in using the disseminated DMTs.

1.2 Statement of the Problem

The uptake and use of DMTs by smallholder dairy farmers in Molo division remain at low levels (MoA & MoLFD, 2004; SANREM CRSP, 2003) because the NFFS extension approaches have not effectively enhanced dissemination of knowledge and skills to farmers in successfully using the available technologies (Moris, 1991; Scarborough *et al* 1997). The low uptake and limited use of the available DMTs (ILRI, 2002) has partly contributed to the low productivity in the smallholder dairy herds. To improve the situation, ILRI introduced the FFS extension approach to smallholder dairy farmers in 2001 to replicate the successes of FFS in enhancing dissemination of knowledge and skills to farmers achieved in integrated management of crop pests, soils and water conservation (Leeuwis *et al.*, 1998; Minjauw *et al.* 2003). However many management aspects of crops, crop pests, and soil and water conservation are not necessarily applicable to those needed in dairy production. This raises the question of whether the success of FFS with management of technologies for crops, pests and soil and water conservation could be successfully replicated in the dissemination of DMTs in the smallholder production systems.

1.3 Purpose of the Study

The main purpose of this study was to establish whether FFS extension approach has any influence on farmers` knowledge and skills about the use and application of the essential DMTs. This was achieved by comparing the knowledge and skills farmers had acquired about the use and application of various DMTs when trained through FFS or NFFS extension approaches under similar socio-economic and biophysical conditions. The results will better inform farmers, extension service providers and policy makers on decisions to promoting and adopting FFS extension approach.

1.4 Objectives of the study

The main objectives of the study were to:

1 To compare the knowledge gained and skills acquired on use of AI technology by farmers trained through FFS and NFFS extension approaches.

2 To compare the knowledge gained and skills acquired on calf rearing technology by farmers trained through FFS and NFFS extension approaches.

3 To compare the knowledge gained and skills acquired on dairy cow feeding technology by farmers trained through FFS and NFFS extension approaches.

4 To compare the knowledge gained and skills acquired on mastitis control technology by farmers trained through FFS and NFFS extension approaches.

5 To compare the knowledge gained and skills acquired on polythene tube silage

making technology by farmers trained through FFS and NFFS extension approaches.

6 To compare the knowledge gained and skills acquired on napier fodder management technology by farmers trained through FFS and NFFS extension approaches.

7 To compare the level of dairy herd productivity achieved by farmers trained through FFS and NFFS extension approaches.

1.4 Hypotheses of the Study

The following null hypotheses tested corresponding to the specific objectives were:

H_{O1} There is no statistically significant difference in knowledge gained and skills acquired on AI technology between smallholder farmers trained through FFS and NFFS extension approaches.

H_{O2} There is no statistically significant difference in knowledge gained and skills acquired on calf rearing technology between smallholder farmers trained through FFS and NFFS extension approaches.

H_{O3} There is no statistically significant difference in knowledge gained and skills acquired on dairy cow feeding technology between smallholder farmers trained through FFS and NFFS extension approaches.

H_{O4} There is no statistically significant difference in knowledge gained and skills acquired on mastitis control technology between smallholder farmers trained through FFS and NFFS extension approaches.

H_{O5} There is no statistically significant difference in knowledge gained and skills acquired on polythene tube silage making technology between smallholder farmers trained through FFS and NFFS extension approaches.

H_{O6} There is no statistically significant difference in knowledge gained and skills acquired on napier fodder management technology between smallholder farmers trained through FFS and NFFS extension approaches.

H_{O7} There is no statistically significant difference in the level of dairy herd productivity achieved by farmers trained through FFS and NFFS extension approaches.

1.5 Significance of the Study

The information generated from this study is useful in evaluating whether the FFS relative to NFFS extension approach is more effective in the dissemination of knowledge and skills to farmers on the use of essential DMTs. This information is valuable to extension agents, farmers, agricultural and livestock policy makers, extension delivery systems and researchers in designing effective educational approaches for disseminating DMTs particularly those targeting smallholder farmers. It provides an objective basis for re-evaluation of future development and packaging of technologies for enhanced adoption by the target beneficiaries. The outcome will be valuable reference for any future necessary improvements on the FFS extension approach and its` possible mainstreaming into the normal public extension delivery systems.

1.6 Scope of the Study

This study was designed to create an understanding of the knowledge and skills of small-holder dairy farmers about the use of various DMTs made possible by participating in FFS or NFFS training extension approaches. The comparison of the skills and knowledge farmers acquired on the investigated DMTs was based on the training of NFFS farmers as the benchmark for measuring any extra knowledge and skills acquired through FFS training. A sample of farmers participating in FFS extension approach was obtained randomly from six locations where ILRI introduced and continues to run FFS extension approach in Molo division. The random sample of farmers participating in NFFS extension approach was obtained from other seven locations where FFS extension approach has not been introduced but farmers continue to participate in NFFS extension approach. The selected DMTs are those emphasised in the extension service for enhancing dairy herd productivity in smallholder systems and include AI technology, calf rearing, dairy cow feeding, control of mastitis, management of napier grass and polythene tube silage making.

1.7 Assumptions of the study

The study was conducted under the following assumptions:-

1. The farmers could report their true experiences of working within groups during the implementation of FFS
2 The identified moderator variables of age, gender, marital status, level of education, source of income, farm size, herd size and milk market outlet could have an influence on farmers` knowledge and skills of the DMTs.
3 The extension staff made a deliberate effort to teach the NFFS smallholder farmers on various aspects of the important DMTs.

1.8 Limitations of the study

The time of data collection concided with unprecedently heavy rains that rendered roads in Molo partially impassable. The poor road network thus adversely affected data collection by delaying the exercise and also rendering it expensive.

1.9 Definition of Terms

Agricultural extension is a process of getting information to farmers and assisting them to acquire the necessary knowledge, skills and attitudes to utilize effectively the information or technology disseminated (Swanson and Claar, 1984).

Conventional extension approaches (NFFS) are the extension trainings characterised by top-down and non-participatory methods that have traditionally been used in the public extension service in the dissemination of knowledge and skills on use of agricultural technologies. In this study they include T&V, FSR and ToT.

Dairy Management Technologies (DMTs) comprises knowledge, inputs and management practices, which are deployed together with productive resources to enhance productivity of a desired output (Reijntjes *et al.*, 1995) from dairy enterprise. In this study, the DMTs specifically include AI, Calf rearing, Dairy cow feeding, Mastitis control, Polythene tube silage making and Napier fodder management.

Extension approach is a style of managing extension aimed at passing agricultural information to farmers to enable them to improve their production. In this study the approaches under investigation will be the FFS and conventional (NFFS) extension approaches.

Farmer Field School (FFS) is a season-long training of farmers involving participatory activities, hands-on analysis and decision-making (Rola *et al.*, 2001). In this study, the FFS extension approach will be the main independent variable.

FFS farmer is used in this study to refer to a smallholder dairy farmer who has already been exposed to the FFS training sessions and graduated and is currently an active member of one of the operating FFS schools (Nyakinyua, Mona, Josiri, Mwangaza, Mau-Summit and Kiambiriria) in Molo division.

Knowledge refers to the sense that people make out of information. It is infused with insights; expertise and capacities of those who have it and can be used to enable people adapt practices Gandelsonas, C. (2002). In this study, the farmers` knowledge is confined to AI, Calf rearing, Dairy cow feeding, Mastitis control, Polythene tube silage making and Napier fodder management.

Smallholder is generally a farmer with not more than 5 acres of land, owns not more than five dairy cows and practice dairying/crop integration as a major source of livelihood (Bebe *et al*., 2003).

Skill refers to the ability of the farmers to use, apply or implement without assistance the essential aspects of AI, Calf rearing, Dairy cow feeding, Mastitis control, Polythene tube silage making and Napier fodder management.

NFFS farmers are defined as farmers who have been regularly trained on dairy production using the conventional extension approaches. In this study, the NFFS farmers are drawn from locations where the FFS have not been introduced for dairy production.

FFS process includes all activities in the FFS approach from ground working, setting of field schools FFS training and graduation. In this study FFS farmers participated in all the activities as entailed in the FFS training process.

Farmer Empowerment is a process of providing farmers with an opportunity to learn and achieve greater control over the conditions that they face every day in their farms. In this study, farmers get the opportunity to use, apply and implement various aspects of DMTs for improved dairy herd productivity.

Influence refers to either positive or negative effects of one factor on another or effect of an agent on another because of a relationship that exists between the two. In this study, the influence of FFS extension approach on smallholders` knowledge and skills of DMTs in Molo division is investigated.

Participation is the process by which people become involved in their own development including some or all of the steps of assessing their own situation and making decisions on research, extension, planning, implementation, monitoring, progress and evaluating outcome (Anandajayesekeram, 2001).

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter contains literature review related to the importance of extension services in agricultural development. It examines the various extension approaches that have traditionally been used in the provision of extension services. The evolved participatory approaches that have been introduced are also discussed with particular emphasis to FFS. The chapter concludes by presenting the conceptual framework that will guide the proposed study.

2.2 Importance of Smallholder Dairy Production

In official statistics (GoK, 2002), the Kenyan livestock sub-sector accounts for 10% of the entire GDP and about 42% of the agricultural GDP. The sub sector accounts for 30% of the total marketed agricultural products through the supply of raw material for agro-industries and the domestic requirements of meat, milk and dairy products and other livestock products. The sector employs about 50 percent of the agricultural labour-force and earns the country substantial foreign exchange through export of live animals, hides and skins, dairy products, and some processed pork products. Livestock sub-sector is a major contributor to household incomes through sale of livestock and livestock products. Dairy production is the most economically important component of the livestock sub-sector. Dairy industry is growing at a rate of 4.1% annually and is accounting for 3.5% of the GDP. It is estimated (Omore *et al*., 1999) that 80% of the country's marketed milk is produced from a population of 3 million dairy cattle. Of this population, over 75% are found in the smallholder farming systems, which accounts for over 70% of the total domestic production and marketed milk, and supports more than 600,000 smallholder dairy households (Omore *et a*l., 1999; Staal., *et al*., 1999). An estimated 84% of the total milk production is sold in the raw form, while 16% is processed. Of the total domestic marketed milk, 55% is through traders, cooperatives, hotels and shops.

Though economically important, several factors constrain sustaining productivity of smallholder dairy production. They face continuous shrinking land size due to continuous sub-division of farms encouraged by the culture of inheritance. Their use of agricultural technologies is also limited to enhance desired levels of dairy productivity. Schreiber (2002) showed in a study of smallholder systems in Western Kenya that lack of information was a major constraint to improved milk production in Kenya. He ranked extension services as the most important category of information, service or input that farmers needed to enhance their dairy production. He further observed that farmers lacked information especially on feeding, breeding followed by general management knowledge. Several workers (Barton& Reynolds, 1996; Staal, *et al* 1998; Schreiber, 2002) have also identified smallholders' critical need for knowledge and skills on feeding, breeding, animal health and marketing in order to increase the productivity of the dairy breeds that they utilise.

Enhanced productivity of the dairy herd in smallholder systems is to a large extent, influenced by the ability of farmers to access and utilize appropriate production technologies. Extension approach is a tool to influence farmers' acquisition of knowledge and skills essential for enhancing dairy productivity. Since land continues to shrink and major inputs have to be sourced externally, intensification of smallholder dairy production is a prerequisite to enhancing productivity. This requires that smallholders become knowledgeable and skilled in using the available DMTs, to which effective extension approaches in technology dissemination is, needed (Rees *et al*., 2000).

2.2.1 Productivity in Smallholder Dairy Herds

Omore *et al*., 1999 observed that of the 3 million dairy cattle in Kenya, 75% is found within the smallholder farming systems. Milk production from the smallholder systems is estimated to be 70% of the total milk produced in the country. Prior to Kenya's independence, the dairy subsector was dominated by the resource rich large scale settler farmers. At post independence, the native farmers were being settled in relatively small landholdings. Since then, their population systematically increased and this has corresponded with a rise in the number of dairy cows and subsequently milk production. Although the country's milk production meets the domestic demand, this has basically been associated to the rise in number of the exotic dairy cattle that farmers kept. However, continuous shrinking in landholdings, the rampant population and a desire to own land has put heavy pressure on the already overworked land resource. This coupled with the fact that smallholder farmers are resource poor and their capacity to exploit the existing potential of the dairy cows they keep is limited, has demanded increased use of external intervention inputs and other resources.

According to Staal, *et al*., 1998; Schreiber, 2000; Barton *et al*., 1996, the smallholder dairy farmers have limited capacities to confront the confounding constraints affecting their dairy herd productivity. Dairy cows are put on inadequate and low quality feeds, there is little use of external inputs and their access to information and knowledge is limited. Smallholder farmers also rely on dense bulky feeds which have low crude protein and their ability to manage diseases particularly mastitis is low to meet the challenges of intensification.

2.3 Extension Service Delivery Approaches

Agricultural extension is the dissemination of information and technologies to farmers by using adult learning techniques. Its` overall goal is to improve knowledge and skills and change attitudes of farmers in order to enhance adoption of new technologies that contribute to improving production, income and general welfare of the farmers. It enables farmers to better use the available resources by increasing technological options and organisational skills (MoARD, 2001). Agricultural extension achieves this by training farmers on how to use technologies effectively to their benefit under their circumstances. However, farmers do not adopt technologies merely because they have been disseminated to them (Swanson and Claar, 1984). They have to learn about them, and in the process, acquire knowledge and skills necessary to the successful use of those technologies. The mode of dissemination can influence the agricultural knowledge and skills that farmers acquire. In Kenya, technology dissemination has been and continues to be the responsibility of the public extension service of the Ministries of Agriculture and Livestock and Fisheries Development (Muchena and Gicheru, 2001). The other organisations that are increasingly providing extension services to farmers include private companies, Non-Governmental Organizations (NGOs) and Community-Based Organizations (CBOs).

According to Pretty (2002), a good extension approach motivates and trains farmers to experiment more accurately on their own and become trainers of others. Conventional extension services were structured and operated on the assumption that farmers were largely passive, illiterate, ignorant and therefore unable to innovate or integrate new livestock or cropping practices into their farming systems (Technical Centre for Agriculture and Rural Cooperation [CTA], 1997). The results of extension services tended to be poor because farmers did not feel ownership of ideas imposed on them (Jurgen *et al*., 2000). A whole systems approach has been favoured (Axinn, 1997) for realising a positive change in rural development. The author adds that agricultural extension approaches must empower farmers to lead extension and exert power and influence over research systems so that there is generation of useful and practical information to farmers' needs and interests. Such extension approach should enhance participation of farmers at all stages of planning, implementation and evaluation through farmer-led approaches to ensure sustainability and the success of any extension programme (Axinn, 1988). The participatory approaches emerged in the late 1980s after it was realized that most technologies developed by researchers alone were inappropriate for smallholder farmers (Jurgen *et al*., 2000). In their study in Northern India, Feder and Slade (1986) found that three-quarters of the farmers cited other farmers as their main sources of knowledge. Birkhauser *et al*., 1991 found that farmers sought for information on new technologies from their neighbours. Working on Potato farming in India, Foster and Rosenzweig (1995) noted that information from neighbours on new technologies was as important as knowledge acquired from government extension services. These experiences serve to show that diffusion of technologies is enhanced by informal methods of dissemination especially from farmer-to farmer (Sinja *et al*., 2004). A good approach utilises rapid and recognisable success to motivate farmers and discourages the use of artificial incentives. It uses technologies that are not expensive, simple and based on locally available resources. Finally it trains some farmers to become trainers. These participatory principles have been adopted in the design of FFS extension approach.

2.3.1 Conventional Extension Approaches (NFFS)

As is in other developing countries, several extension approaches have been used in Kenya (Byerlee, 1994) without much success. These include Transfer of Technology (ToT), Farming System Research (FSR) and Training and Visit (T&V) Approach.

Transfer of Technology (TOT) Approach

This approach dominated research and extension during the 1950s and 1960s (Godtland *et al.*, 2004) where the technologies were developed in research stations and often in environments different from those of the farming communities. During this time the prevailing view was that scientific knowledge applied to problems of rural poverty in developing countries would provide the necessary impetus needed to transform rural people's lives and increase their welfare (Warburton *et al.,* 1999). New technologies were generated and transferred to extension services for dissemination to the farmers. Emphasis of technology development and transfer was on the adoption and non-adoption of technologies without regard to how knowledge on their use was acquired. Information transfer was one way from agricultural extension to farmers with little or no direct feedback from rural farmers to research and development.

There was lack of two-way flow of information between extension workers and farmers. This extension approach was mainly regulatory and characterised by some level of coercion that was aimed at compelling the native farmers to produce raw materials for the colonial industries. This technology transfer approach did not facilitate farmer participation in technology development and dissemination. It was characterized with weak linkages to research and criticisms of ToT include the following. There was a growing evidence of many development projects not working at all and farmers were not adopting recommendations. It was further discovered that the recommendations and technologies were not always appropriate to the farmers` circumstances. There was concern that the rural people's knowledge of their environment and farming systems, and their social and economic situation had been ignored and underestimated.

The failure of farmers to adopt new technologies was blamed on their ignorance and backwardness (Asiabaka, 1999; de Boef *et al*., 1993). The approach was also plagued with administrative difficulties. The extension agents were assigned other duties apart from transfer of knowledge to farmers. The approach did not attempt to target specific groups of farmers. The focus was mainly on individual crops or livestock rather than the entire household economy. The ToT approach used mainly face-to-face communication with little use of mass media. The extension workers were insufficiently educated and supervised and had no organised system of communicating feedback from farmers to researchers (Feder & Slade, 1986; Piccioto & Anderson, 1997). There was no clear line of supervision and emphasis was on providing advice with technology transfer goals rather than as opposed to educational goals. As a result of the shortcomings of the ToT and complexities of problems at the farm level, a new approach, the Farming Systems Research was introduced.

Farming Systems Research (FSR) Approach

After realising that smallholder farmers were interested with offsetting the multiple risks present in their environment, the FSR was introduced in the 1970s to focus its effort on the farm with scientific practices aimed at solving the farmer's problems. This approach was merely used to test and refine the developed technologies on- farm and could therefore not address farmer's problems effectively.

Training and Visit (T&V) Approach

As described by Birkhaeuser *et al.* (1991) and Hakiza *et al.* (2002), T&V was an extension approach used in technology diffusion with focus on a better deployment of extension field workers. It was introduced in Kenya by the World Bank and implemented through two successive projects. It was the favoured extension approach that the World Bank preferred during the 1980s and 90s. The T&V extension approach concentrated on the transfer of agricultural knowledge and technology from research to farmers. The main objective of this approach was to increase agricultural production. It assumed that farmers lacked adequate knowledge that inhibited production increases. The approach thus was geared at making scientific and technical knowledge and solutions available to the farmers. It tended to focus on identifying useful knowledge messages and diffusing them to farmers. Under T&V the extension system was reoriented from a desk-bound bureaucracy with multiple economic and social objectives to a field-based cadre of agents who focused mainly on technology diffusion (Piccitto & Anderson, 1997).

The T&V tried to improve the effectiveness of existing extension resources. Although the flow of communication between extension and research units was improved, flow of communication from farmers to extension staff and especially from mixed enterprise producers was lacking. Contact farmers were used to disseminate information to their respective communities. To improve feedback absent in the FSR, T&V was designed to transfer information and technology from researchers to contact farmers via the front line extension workers with a feedback mechanism from farmers to researchers using the same channel. With T&V, there was improved farmer training. Research- Extension-Farmer linkages and communication flow between extension and research centres was improved. The specialists, subject matter specialists made decisions about which crops to concentrate on and which crop areas to be taught to farmers. The extension activities followed a rigid schedule with little input from farmers with the result that programmes tended to lack relevance to local farm problems.

Evaluation studies done on T&V approach in Kenya found it neither effective nor sustainable for over the nearly twenty years of its existence (WB-OED 1999). Although it was designed for crop production in homogeneous conditions, T&V was subsequently also implemented in all kinds of rainy-fed environments where farmers with a diversity of problems produced under a great variety of conditions. This approach was however heavily top-down and left little opportunity for participation and initiative by farmers especially in deciding programme goals, implementation and evaluation. The chain of command was for researchers to produce scientific knowledge, the extension agents to disseminate it and for farmers to accept it and use the scientific knowledge. The top-down delivery of information assumed that the scientific knowledge produced within research contexts would be useful to farmers.

The WB OED 1999 proved this assumption false in many contexts as was illustrated by such reports. With T&V, there was over reliance on individual contact farmers. It also put excessive emphasis on message delivery. The approach was not designed to help farmers develop their own skills for acquiring or analyzing knowledge or information (Schuh 1999). In 1999, the World Bank's evaluation of T&V established a mismatch between what farmers wanted (advise on complex messages) and what they actually got (simple cultural messages), the methodologies preferred by farmers and what the extension agents used (WB-OED 1999). This approach tended to focus on individual crops or livestock rather than the entire mixed household farming system. Emphasis was put on a cadre of subject matter specialists who had research and training functions in addition to extension roles.

This approach offered standardized technological solutions to farmers who suffered from a diverse range of problems. T&V extension approach with its focus on individual contact farmers did not reach a wide range of farmers. It demonstrated a centralized control of programme planning with decisions on what enterprise to concentrate on and which practices to be taught to farmers made by the subject matter specialists (professionals). Since extension activities followed a rigid schedule with little input from farmers, the results often lacked relevance to local farm problems. T&V was also criticised as too expensive and difficult to implement. Highly dispersed farmers could not establish frequent contact with the extension agents. Needs of the heterogeneous groups of farmers varied widely and could not be addressed with a single inflexible technological package (Feder *et al.,* 1998; Piccioto & Anderson., 1997). Schuh (1989) showed that T&V did not promote the development of cognitive skills or farmers` ability to think things through on their own. It did not help farmers develop their own skills for acquiring and analysing knowledge or information. Some observers contended that a rich variety of extension approaches might better meet the diverse needs of different groups and types of farmers than T&V (Antholt, 1994). The World Bank ultimately dropped the T&V as a preferred public system extension approach. Due to those weaknesses; the impact of T&V was low knowledge and poor production skills of the farmers about the available technologies. Subsequently adoption and use of agricultural technologies in the smallholder farming systems remained limited.

2.3.2 Characteristics of the NFFS extension approaches

The NFFS (ToT, FSR and T&V) extension approaches are Government controlled with top-down approach in transferring agricultural technologies aimed at solving production constraints. They are supply driven and externally initiated without the involvement of the target farmers, hence not farmer-problem oriented (LDG., 2004). Farmers are insufficiently involved or not even involved at all in identifying own production problems, selecting, testing and evaluating the possible solutions. The NFFS approaches involve extension staff using group techniques like meetings, field days, demonstrations, and tours (Bradfield, 1971; Maunder, 1973). The linkages between research, extension and farmers are weak; farmers are treated as passive recipients. Although the T&V improved communication flow between extension and research, the flow of communication from farmers to extension remained lacking.

Technological packages are transferred to farmers without alternative technologies that farmers can evaluate by themselves. The NFFS approaches adopt learning process through instruction rather than facilitation. Farmers are seen as end users who rely on uniform technologies and follow blanket recommendations of the extension instructors. The NFFS model does not embrace the use of collaborative effort of researchers, extension service, educators and farmers in the generation and dissemination of new agricultural knowledge and skills. It is a one-directional approach to technology transfer without the provisions for stakeholders' participation. The ability of a farmer to take risks is thus not adequately enhanced.

The successes of NFFS are reportedly low in disseminating agricultural knowledge and skills to smallholder farmers (Morris, 1991; Scarborough *et al*., 1997; Wambugu, 1999). Hefferman *et al*., 2000 have attributed this failure partly to their non-participatory nature, inability to address farmers' priority issues and giving inappropriate recommendations and with lack of immediate tangible benefits to farmers. Evaluations of these NFFS extension approaches have concluded that they have been ineffective in disseminating the necessary agricultural knowledge and skills (LDG., 2004). Consequently, the Government is reducing its support for NFFS (MoA & MoLFD, 2004). This has prompted a need for alternative methods of disseminating agricultural technologies to farmers, necessitating the change to participatory approaches in extension services (Asiabaka, 1999).

2.3.3 Farmer Field School Extension Approach (FFS)

To address the weaknesses associated with the NFFS, alternative participatory approaches have been developed. The participatory approaches emerged after it was realised that most technologies developed by researchers alone were not appropriate for smallholder farmers. The Focal Area Shifting Approach (FASA) commonly referred to as the National Agriculture and Livestock Extension Programme (NALEP) is presently being implemented in the delivery of public extension in Kenya. NALEP has adopted a whole farm approach although no impact study has been carried out to evaluate its performance. The other participatory approach is the Farmer Field School (FFS). The FFS is an adult education tool meant to enhance management and social skills. It applies the principles of non-formal education where learning is done outside the formal school system (Dilts, 1983). FFS is based on Paulo Freire`s (1972) perspective on education as a problem solving and consciousness raising strategy for empowerment. Its` empowerment effect is based on engaging farmers in a process of group discovery learning that allows them to make their own observations, draw their own inferences and make their own informed decisions.

The FFS extension approach was conceptualized in 1989 when an inter-country IPM programme was designed by FAO to train farmers on integrated pest management in rice based cropping systems in Indonesia (Kenmore 1991). It recognized the characteristics of sustainable agricultural development as being people-centred knowledge intensive and location specific (van de Fliert *et al.,* 1993). People centred extension approaches enhances farmers` ability to put in practice what they have learned and further teach them how to create or exploit opportunities for further learning. All FFS learning activities apply the concept of learning cycle. According to Kolb (1984) the learning cycle consist of four learning stages; concrete experience, observation and reflection, generalization and abstract conceptualization; and active experimentation.

In recent years, a number of development agencies such as ILRI and LOL have promoted FFS as a potentially more effective approach to extend knowledge to farmers. FFS programmes were first introduced in East Asia in the late eighties as a way of diffusing knowledge-intensive integrated pest management practices for rice. Although the FFS history is linked to IPM and pests, the concept and FFS agenda has now been successfully expanded to other issues such as soil fertility, crop production and lately human health. Participatory approaches facilitate farmer demand for knowledge, give them the opportunity to choose, test and adopt technologies according to their needs. Activities are collectively carried out in groups and are intended to strengthen the capacity of farmers to work together, to share information and to learn from each other (Van de Fliert, 1993).

Monitoring and evaluation studies done on a pilot programme of sweet potato integrated crop management in Indonesia showed that participation in the FFS enhanced farmers` crop management knowledge and skills (Van de Fliert, 2000). The FFS encourages farmers' participation in formulating their agenda, the content and the dissemination pathway (Garforth, 1998). Instead of transferring fixed technical packages, the extension team presents groups of farmers with alternative potential technologies to evaluate them. This recognizes the farmers` critical roles of evaluating the rewards, risks and costs of technologies before adoptions. This allows farmers in diverse production environments to experiment locally and adopt a flexible range of technologies.

2.4 Design of FFS Extension Approach

The FFS extension approach is designed to enhance farmers' agro-ecological, science-based knowledge and skills needed for informed decision making and problem solving, such as agro ecosystem analysis, experimentation and cost-benefit analysis. It applies integrated curriculum in which farmers generate the learning materials. Extension agents teach farmers in the field on relevant agricultural practices. Through interactive learning and field experimentation, farmers are trained on how to experiment and solve problems independently. Experience-based learning is linked to daily living problems. It tries to empower people to actively solve the ensuing problems by fostering participation. By doing so, people develop self-confidence and make decisions jointly. Lecturing is not used in Field schools. Trainers facilitate experiential learning process by organizing adequate learning activities and providing crucial information where needed. Facilitators do not allow themselves to be forced into roles of experts and do not answer questions directly but try to make farmers think for themselves. With the FFS, farmers conduct their own field studies. They work in small groups and collect data from the field, analyse it, and take action based on the analysis of the data. Farmers request for a series of topics to be dealt with in FFS training sessions and therefore highly influence the direction of the learning process.

They share their knowledge with other farmers and are trained to teach the courses by themselves in a participatory manner. The dissemination of innovations develops spontaneously when one farmer has successfully tested a new practice or technology, attracting the interest of other farmers. It creates conditions for optimal farmer learning and informed decision making abilities. Farmers consequently perceive themselves as experts in, and managers of, their own fields. FFS gives farmers power to evaluate the recommended research technologies at some level and select the best-fit package for adoption and production. Through FFS, farmers take charge of organizing experiments, leading discussions, making plans and accomplishing tasks previously considered too complex for the average farmer to apply (Hakiza *et al*., 2002). This approach relies heavily on farmer-to-farmer spread of knowledge to accelerate the acquisition of skills and subsequent diffusion of new ideas.

FFS encourage free and open communication, which creates trust among each other and encourages farmers to freely learn from one another. Problems discovered in practice become topics for discussion. All farmers participate actively in the learning process. Extension workers acquire and use facilitation skills. Learning is directly related to daily farming experiences and problems. Farmers are expected to practically participate in all the FFS steps. Participation of farmers in the on-farm experimentation enables them to develop competency hence they can try the technologies on their own farms. At the on-set of FFS, farmers holistically identify their problems and map out resources available as a basis of selecting the relevant inclusions in the season-long training (Okoth *et al*., 2002).

FFS approach recognises and encourages farmer-to-farmer extension and gives them greater choice of their source of information, which supports the long-term sustainability of their farming systems (Miagostovich, 1999). FFS has since been adapted to work with other crops and diseases and has spread rapidly across Asia, Africa and Latin America (Nelson *et al*., 2001). It is being implemented in Kenya on a fairly wide scale but mainly on crops and soil management where it has been successful (Minjauw *et al.*, 2003).

In an evaluation based on Uganda and Kenya, Fujikasa (2000) recognized the positive contribution of FFS (IPM and soil management) to sustainable livelihoods. Borrowing from the approach's success in crops, the International Livestock Research Institute (ILRI) and Land`O Lakes (LOL), extended and are running the FFS for the Smallholder dairy farmers. The demand led proponents of FFS approach believe that when the farmers who are users of knowledge demand information, the relevance and uptake will be assured (LDG, 2004). As an empowering process, FFS education stresses the importance of learning processes and relationships as they affect the learners and not only on the contents. Roling (2002) however expressed fears of real threats of expanding FFS to other crops and technical issues as a shift of focus from transferring correct scientific knowledge to getting it right. In South East Asia, the FFS approach nevertheless was applied to build farmers decision-making and analytical capacities in other areas other than farming (Banu & Bode, 2002). This is in compliance to one of the aims of FFS of building cohesiveness in the groups that can be used to disseminate knowledge to other farmers. Rola *et al*., (2000) measured the successes of FFS and found out that the approach enhanced the acquisition of knowledge on sustainable agriculture by graduate farmers, changed their attitudes and improved the farming practices and efficiency of production.

Dairy FFS has wholesomely adapted a curriculum developed by agronomists specializing in integrated pest management (IPM) albeit with minor modifications to suit the dairy enterprise. Although the application of FFS in crop management has been successful, major differences exist between crops and dairy enterprises as illustrated earlier in Table 1. The farmers in Kenya and elsewhere have expressed demand for FFS use in livestock production; but no tailored curriculum has been developed to specifically address the issues of dairy enterprise. FFS was conceptualized and developed by agronomists to address IPM issues and the current curriculum thus focuses itself on crops. Although the successes of FFS in crops and soil management practices has encouraged research and NGO organizations to adapt and use this approach to enhance the smallholder dairy farmers` knowledge and skills of dairy management, the curriculum in use is a modification of the one used for crop production. Yet crops significantly differ from dairy in many aspects. Currently, there are over 1000 FFS based on crop production and soil management being successfully implemented in Kenya (Minjauw *et al*., 2002).

Ecosystems analysis was adapted to make animals the focal point and participatory technology development (PTD) techniques utilised to address livestock related issues. Since then other dairy FFS are being started as participatory approach to facilitate farmer demand for knowledge, give them the opportunity to choose, test and adopt technologies according to their needs. LOL is running 40 dairy FFS for the smallholder farmers in Kenya. This study will examine the influence of dairy FFS approach on farmers' knowledge and skills of the various dairy management technologies with a view of changing their attitudes towards adoption.

2.5 Dairy Management Technologies (DMTs)

The need for increased adoption and use of agricultural technologies by the smallholder farmers has prompted a continuous search for approaches that can enhance the dissemination of technologies and information. Technologies are developed in research stations, and if farmers do not have access to them, their development would have been in vain (Bremer *et al.*, 1989). If a technology is to contribute towards reducing the poor people's food insecurity, then it has to be suitably disseminated to reach its` potential users. The educational process used to equip individual farmers with the necessary knowledge and skills for using the innovations forms a critical component of adopting the technologies (Rosenberg, 1982). If a technology is less observable or communicable, then the chances of it being undervalued relative to traditional practices (Table 2) are high and this will hinder its adoption (Mansfield, 1997). Technologies may be economically useful and technically efficient but may not gain market acceptance because the potential adopters are not aware of them or how to use them.

Dissemination pathways create awareness and educate farmers about the innovations. By doing so, these actions develop ones` capacity to analyse the benefits and costs associated with the technologies and thus enhance their adoption. The agricultural research system must therefore conceptualize effective mechanisms and capacities to not only implement the transfer of results but also to measure farmers` knowledge and skills of these technologies. The priority the Kenyan government has given agricultural research is demonstrated by the elaborate network and support accorded to the Kenya Agricultural Research Institute (KARI), public and private universities and other national and international agricultural research bodies operating locally. All these institutions are involved in both basic and applied agricultural research. However the full potentials of agricultural research in Kenya is far from being attained as the use of modern technologies in the production systems is still limited

(MoA & MoLFD, 2004).

Table 2: Some traditional and modern dairy management technologies

Management aspect	Modern dairy technologies	Traditional dairy technologies
Calf rearing	Bucket feeding, Quality forage feeding Housing requirement for calf pens	Suckling Grazing natural pastures
Animal health	Control of mastitis through use of conventional practices	Using herbs and roots
Feeding and feed conservation	Use improved fodders and pastures such as napier grass Polythene tube silage making	Grazing on natural grasses Maize stover preservation
Breeding	Artificial insemination technology	Use of local bulls
Routine herd management	Record keeping on production, health and reproductive performance	No records kept

The goal towards sustainable food production thus remains unachievable. Farmers have different understandings of research generated dairy management technologies. Scientists lack a clear understanding of how farmers receive and interpret information about technologies yet this is what determines their decisions on uptake and use. Farmers are not passive consumers but active problem solvers who develop for themselves most of the technologies they use (Kaimowitz & Merril-Sands, 1989). Before the advent of modern agricultural research, farmers undertook their own research and integrated technology from different sources and continued to adapt it on their farms. People will adopt a technology whose knowledge they acquire and if it will improve their means of livelihoods (Oladele, 2001). With FFS the farmer is a partner in the process of developing opportunities for innovations.

Improvement of milk production is largely dependent on the use of modern dairy management technologies by the smallholder farmers. According to Vago (1990), technologies developed for farmers have characteristics that influence their acceptance or rejection. They are accompanied by relevant information that positively influences their acceptance. Uptake of technologies will be slower when knowledge concerning their use is lacking (Vago, 1990). Availability of information regarding technology use and potential benefits is an overriding factor in farmers` decision making (Byerlee & de Polanco, 1982). If farmers are resource poor, with no access to working capital and their knowledge of the technology is limited, they may not see the relevance of using the innovations for milk production.

The traditional technologies mainly stress on the use of locally and cheaply available materials such as direct grazing on natural grassland, use of bulls for breeding and herbal concoctions for the control of mastitis. Modern technologies on the other hand, emphasize the use and conservation of high quality fodders and pastures, artificial insemination for breeding, conventional drugs and use of appropriate packages for control and management of mastitis. They also emphasize the use of modern housing, feeding and disease control strategies for calves. The most important aspect of the development of these technologies is to enable farmers to access them and acquire the knowledge necessary for their successful use. This goal can be realized by use of an effective agricultural extension approach that can disseminate the dairy management technologies to the farmers (Quizon *et al.*, 2000). Table 2 presents a summary of the modern dairy management technologies and their traditional alternatives.

2.5.1 Artificial Insemination Technology

The small landholdings and increased intensification of production has precipitated a higher demand of feeds and other feeding resources. Much effort has thus been concentrated on the feeding of the milking cow. The keeping of a breeding bull at the farm level will further constrain the already limited feed resource. This in addition to a need for higher genetic material, prevention of breeding diseases and control of inbreeding has enhanced a need for the use of AI. Bebe *et al*. (2003) observed that farmers practicing more intensive production systems attach a higher importance to genetic improvement of their cattle. However the low conception rates and long calving intervals witnessed at the smallholder farmer level, has put the farmers` knowledge and skills of AI technologies into close scrutiny.

A recent study by the Smallholder Dairy Project (SDP) characterisation and longitudinal monitoring of smallholder dairy farms in Rift Valley Province indicate that the smallholder farmers considered inadequate supplies of quality and affordable breeding materials as a major constraint to increased dairy production. Farmers must have adequate knowledge concerning the potential risks associated with the introduction of a modern technology. The introduction of an improved technology such as the use of artificial insemination may produce a high-grade cow that can be highly susceptible to East Coast Fever disease. Farmers will need skills to assess the potential risks and compare them with those emanating from the traditional technologies before making a judgment about the adoption of the innovations. Knowledge of risks give farmers confidence to use technologies and this makes them ultimately gain more experience with the introduction of a new innovation (Nicholson *et al.,* 1999).

Diseases like East Coast Fever that may be prevalent in an area may cause considerable economic damage (Batz *et al.,* 1999). The possible disaster associated with loss of a cow makes farmers sensitive to risk increasing technologies relative to the traditional ones. Having this information and knowing which technology characteristics proved to be important for farmers' decision-making in the past allows planners in research and extension to determine characteristics of new technologies that will lead to high uptake and adoption. In a study in Burkina Faso and Guinea, Adesina and Baidu-Farson (1995) found that farmers' knowledge of varietal characteristics of sorghum was positively related to adoption. They also found age of the farmer to relate to technology uptake. The farmers` skills shape their subjective preferences for new agricultural technologies.

2.5.2 Calf Rearing Technology

The sustainability of the smallholder dairy sub sector depends on the farmers` capacity to rear own high genetic quality replacement stock on farm. An average quality incalf heifer sells at between Ksh 40,000- 75,000 each (Lanyasunya *et al*., 2000). The high price tag is far beyond the reach of the resource poor smallholder farmers and this emphasizes the need to rear own replacement stock. However the average calf mortality of 35 % (Gitau *et al*., 1994a and b) represents a major economic loss to the farmer. The main underlying factors limiting calf survival and performance in smallholder farms include poor housing and management, inadequate feeds and feeding and poor disease control strategies. These limitations are attributed to the farmers' inability to access and use relevant DMTs at the farm level. Lanyasunya *et al*., 2001 observed that use of improved calf rearing technologies hold considerable potential for increasing dairy production through increased availability of replacement stock, efficient use of better feed resources and enhanced dairy husbandry knowledge.

2.5.3 Cow Feeding Technology

Although the dairy sub sector contributes substantially to the livelihood base of smallholder farmers, in Molo division, the levels of milk production is lower than the expected potential of the breeds kept by farmers. This has been largely due to the nutritional problems associated with inadequate feeds and poor feeding. Competition of dairy enterprise with food crops has resulted into less land spared for pasture and fodder development. Walshe *et al*., 1991; Devendra and Sevilla, 2002 indicated lack of quantity and quality feeds as a major constraint to smallholder dairy production. In an effort to enhance their dairy productivity, smallholder farmers in Molo have been intensifying their feeding practises. Bebe *et al*., 2003 observed that intensification of smallholder production systems involves the adoption of better management practices and technologies that will increase output and / or value from the major limiting production resources of land, capital and labour. He singled out lack of feeds as a most important constraint limiting milk production in the Kenyan highlands. This observation agrees with that of Abate *et al*., 1987 that ranked nutritional limitations in terms of quality and quantity feeds to limit production.

The common forages in Molo do not provide sufficient feed to fully exploit the genetic potential of the breeds kept and this leads to low milk production and consequently diminished income. Smallholder farmers there use bulky feeds which are not nutrient dense. Bebe *et al*., 2003 found the use of more low quality feeds to only maintain the animal but not improve milk production and reproductive performance. To enhance their capacity to supply dairy cows with adequate quality feeds, farmers must readily access appropriate DMTs and the knowledge and backup information necessary for their use.

2.5.4 Mastitis Control Technology

Using pairwise and matrix ranking, FFS trained facilitators working with established farmer groups prioritized the main constraints to improved efficiency in smallholder milk production as; 1 poor feeding strategies 2 fodder establishment and conservation 3 calf rearing and mortality 4 tickborne diseases and mastitis and 5 breeding programmes (Minjauw *et al*., 2002). Smallholder farmers experience heavy loses as a result of their inability to prevent and manage mastitis infections in the herd. Such loses manifest themselves in form of reduced milk production, high costs of curative drugs and frequent milk rejections from the creameries. Some of the mastitis causing parasites are zoonoses and capable of infecting man. Although the predisposing factors of mastitis infection are dirty milking environment, unhygienic milking containers and personnel and lack of proper preventive strategies, the smallholder farmers in Molo continues to record higher loses associated with mastitis. This is despite their exposure to the conventional extension trainings on clean milk production. Farmers continued to lack the capacity in terms of knowledge and skills to ensure clean milk production, early detection of mastitis infection and the general preventive and control strategies in order to minimise loses.

2.5.5 Polythene Tube Silage Making Technology

Using participatory pairwise and matrix ranking, facilitators trained in FFS approaches worked with established groups and prioritised the main constraints to improved efficiency in milk production. Fodder establishment and conservation was ranked as the second most important constraint to smallholder milk production (Minjauw *et al*., 2002). Within the Kenya highlands, a bimodal rainy pattern experienced correspondingly avails adequate and sometimes surplus feeds during the wet seasons. This is because livestock production systems are depended on rain-fed pastures and fodders. The wet season normally experiences overproduction of forages and although milk production is high, the producer prices are usually low at such times. A season of dry spell running from November to March is normally characterized by severe feed scarcity. Scarcity of feeds and poor feeding consequently results into low milk production despite the good prices at the dry periods.

The most important extension intervention has been to empower farmers to conserve surplus wet season feed for the dry period feeding when milk fetches higher prices. One way of doing so, is by conserving feeds in the form of silage. However, the traditional trench silo or above ground silage making has not been cost effective to the majority smallholder farmers. High costs of silage making materials, chopping and compaction machinery and the intensive labour requirements has previously relegated silage making to the resource endowed large-scale farmers. However, a new technology of polythene tube silage making that is not only cost effective but also less labour intensive is a handy package for the smallholder dairy farmers. Farmers can use their own labour and make silage from a small quantity of forages grown on the farm. By conserving silage for dry season feeding, farmers will produce more milk and optimise their income from good prices offered during the dry seasons. What farmers lack is the knowledge and skills necessary for polythene tube silage making.

2.5.6 Napier fodder Management Technology

The Friesian and Ayrshire breeds dominate the smallholder production systems in Molo division. These breeds have a heavier mature body mass with higher nutritional demands and according to Kahi, *et al.*, 1998, Rege, 1998; Ojango, 2000; Wakhungu, 2000; they have performed poorly under smallholder feeding conditions. To meet the challenges of intensification of dairy farming in Molo, farmers have resorted to the development of pastures and fodders on their farms. Napier grass *(Pennisetum purpureum*) has been adopted as the most important basal feed for the smallholder farmers. Batz (1999) found napier grass to be the main animal feed under the intensive crop/livestock farming systems. However the on-farm dry matter yields of Napier grass in the Kenya highlands that only averages 16 tons/ha/yr when using limited fertilizer is insufficient (NDDP, 1984). Thus the development and management of napier grass under smallholder circumstances has hardly supplied enough dry matter for the larger breeds that farmers keep.

The area set aside for napier grass establishment is usually small; the agronomic practices are poor and farmers lack appropriate napier grass utilization skills. The low dry matter supplied to the cows means inadequate crude protein and this leads to low milk production. Among the sample study, there was little attention in terms of fertilizer application and proper weeding of napier grass. Farmers preferred applying more manure to food and horticultural crops than to the napier grass and this has resulted into production of low dry matter from napier grass at the farm level. Low application of manure corresponds to low nutritive value of the napier and reduces the regrowth of the sward. The poor management of this popular basal feed that forms the bulky of the roughage for the dairy cows means a supply of low crude protein especially during the dry season. The poor management strategies has resulted into its` diminishing availability of quality and quantity napier grass subsequently impacting negatively on the smallholder milk production.

2.6 Farmers` Knowledge

For smallholder dairy farmers to effectively respond to the diminishing land sizes, they must intensify their production practices. Intensification requires prompt access and use of modern production technologies. For optimal use of such technologies, smallholder farmers require relevant knowledge for their successful use. Several authorities have directly linked knowledge to development. The World Bank, 1998 observed that knowledge was the most important parameter to any development. In 2002, Gandelsonas linked knowledge to facts, feelings or experiences that people own and use for development. Farmers need knowledge on technology characteristics like complexity, potential risks associated, compatibility and applicability before they make a judgement on whether to use or not to use it. However farmers need to access such knowledge before they translate it to any meaningful development. Gibbons *et al.*, 1994 indicated that it was not the creation of knowledge that was problematic in smallholder production systems but rather its` transfer within the dairy production context.

Modern technologies require translations to smallholder farmers who face persistent production challenges. In agriculture and other natural resource sector, there is concern that new knowledge is not being transferred to potential users; or that outputs of scientific research are not being taken up by farmers (Garforth *et a*l., 1997). If a technology is to contribute towards reducing the rural poor farmers` food insecurity, then it has to be suitably promoted to reach such potential users. Knowledge acquisition is thus the ultimate goal of farmers whose results is measured by changes in the smallholder farming behaviour. Hefferman and Misturelli (2000) indicated that a key parameter important to uptake of technologies is their access to relevant knowledge. Access to knowledge relates to delivery systems. It also depends to awareness or perceptions of the technologies to individual farmers. With failure of the conventional top down extension approaches, less confidence was accrued to scientific knowledge in agricultural development (Livestock Development Group, 2004). That very little knowledge reaches farmers might be partly responsible to the low uptake of production technologies. In Indonesia, van de Fliert, 2001 showed that FFS farmers who participated in integrated sweet potato production enhanced their crop management knowledge. Godtland *et al.*, 2001 indicated that participation in FFS significantly impacted knowledge on pests in Peru. He further observed that farmers with higher levels of knowledge had significantly higher levels of productivity. Although FFS has been successful in farmer empowerment in crops, soil, water and pest control, the dairy enterprise management aspects significantly differ from those of crop enterprise. LDG (2004) indicated that research generated technologies is not readily transformed into farmers` knowledge and that gaps in farmers` knowledge has not been effectively addressed. For farmers to enhance their production skills, they must readily access knowledge about the use of appropriate technologies.

2.7 Farmers` production skills

Farmers` production skills emanate from their changed behaviours. Extension approaches aim at enhancing farmers' capacity to access and apply or use improved production packages with the goal of increasing their productivity. Monitoring and evaluation studies done on a pilot programme of sweet potato (Ipomea *batata* (L) Lam) Integrated crop management FFSs studies in Indonesia showed that participation in the FFS enhanced farmers` crop management skills (van de Fliert *et al.*, 1999). FFS farmers who had acquired better skills made careful field observations, made inferences from data collected during observations and conserved natural enemies only when the situation demanded. They applied more concrete production practises than the NFFS trained farmers. Rice farmers in a Central Javanese district who had participated in FFS training sessions made better informed decisions that were based on regular field observations. Many of the trainees felt much more confident in managing their rice fields and taking better and informed pest control decisions (Van de Fliert., 1993). Godtland *et al*., 2004 observed that farmer participation in FFS for potato cultivation in the Peruvian Andes improved their production practices resulting to higher yields.

The farmers trained through the FFS changed their cultivation practices and this led to increased net income as a result of reduced cultivation costs and/or increased yields. More efficient use of external inputs was demonstrated on collective learning through the FFS. van de Fliert 2001 singled areas where farmers` skills were enhanced to include, routine field observations, experimentation, fertilization, seedbed preparation, pest management (none or reduced pesticide use) and vine lifting.

Another impact study of cotton FFS farmers in Asia showed participation in the FFS training improved farmers' cotton management practices. Since the FFS inculcates increased farmer ability to experiment in their own fields, observations in the field confirm that farmers do have better skills and more interest in learning by doing.

2.8 Conceptual Framework

The theoretical basis for developing this conceptual framework borrows from Hackman`s Normative theory that emphasized on teamwork and participation for effective performance of specified tasks. The concept of group thinking and sharing of ideas highly and positively influences the members' empowerment capacity. The product of group thinking is distinctly superior to that of an average person in the group and even to that of the best member. FFS extension approach encourages higher farmer participation in the learning process and invokes the extra power provided by interactions within a group.

This study adopted the conceptual framework illustrated in Figure 1. It is an adaptation of Hackman`s normative model of group effectiveness (Forsyth, 1990), which emphasizes the influence of group participation and technology transfer approach on farmers` knowledge and skills.

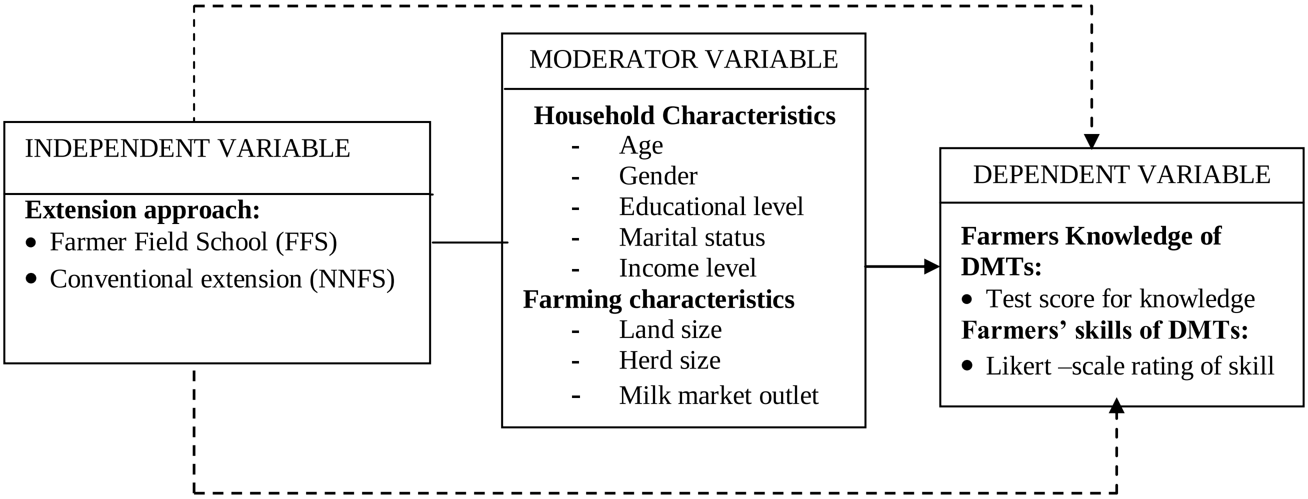

Figure 1: Conceptual framework showing the influence of FFS extension approach on smallholders' knowledge and skills in dairy management (Modified from Hackman's normative model of group effectiveness, Forsyth, 1990)

The independent variable is the extension approach (FFS and NFFS), which has been used in formulating the study objectives, hypotheses and data collection instrument for this study. Its` influence on farmers' knowledge and skills of DMTs was investigated. The FFS involves regular training sessions, hands-on experimentation, routine monitoring and observations of trials, group dynamic exercises, exchange visits and tours. These characteristics of FFS approach relative to NFFS are expected to positively influence farmers` knowledge and skills about dairy management technologies. The moderator variables formulated include characteristics of the household (age, gender, educational level, marital status, source of income) and farming (land size, herd size, milk market outlets). These variables may have an indirect influence on the way farmers learn about the selected DMTs. The moderator variables are important production factors that were inbuilt in the study in order to isolate their influence on farmers' knowledge and skills of selected DMTs.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the research methodology employed in the study. It outlines study site, the study population, survey design, the sampling technique and the analytical procedure used. It also explains about the instrument used and its validation process and enhanced reliability.

3.2 Research Design

A cross-sectional survey design was used to sample farmers participating in FFS and NFFS extension training approaches, in line with recommendations of Wiersma (1986) for studies involving sampling from a specific population at only one point in time. This design was preferred for the study because, as compared to longitudinal survey, it allows for data collection under natural setting, is relatively quick and cheaper to undertake, and the results can be inferred to the larger population. Its application allows for collection of household level data for both qualitative and quantitative comparison of farmers participating in FFS and NFFS for the level of knowledge and skills on the use of DMTs commonly promoted in extension services.

Sampling was random and the sample size relatively large to reduce biases in the results arising from chance differences between the samples and some extraneous factors manifested in the observed change other than the independent variables of interest (Ary *et al*., 1979). The NFFS farmers were drawn from locations where the FFS extension training approach has not been introduced. The FFS locations were similar to the NFFS ones in terms of physiographic, socio-economic and accessibility to milk market outlets. The FFS farmers were sampled far apart from NFFS farmers so as to limit chances of the two groups having been actively interacting in extension services.

3.3 Study Location

The study was done in Molo division of Nakuru district, an area covering 629 km^2 of land (CBS, 2000). The division has a total of thirteen locations and forty sub-locations. Molo division was selected for the study because it is one of the areas where FFS was introduced to smallholder dairy farmers by the International Livestock Research Institute (Minjauw *et al*., 2001). The adoption of extension promoted DMTs by smallholder farmers in this division is reportedly low and so is the dairy herd productivity (MoA &MoL&FD, 2004; SANREM-CRSP, 2003). Figure 2 shows the location of Nakuru district in Kenya and the study locations in Molo and Rongai divisions.

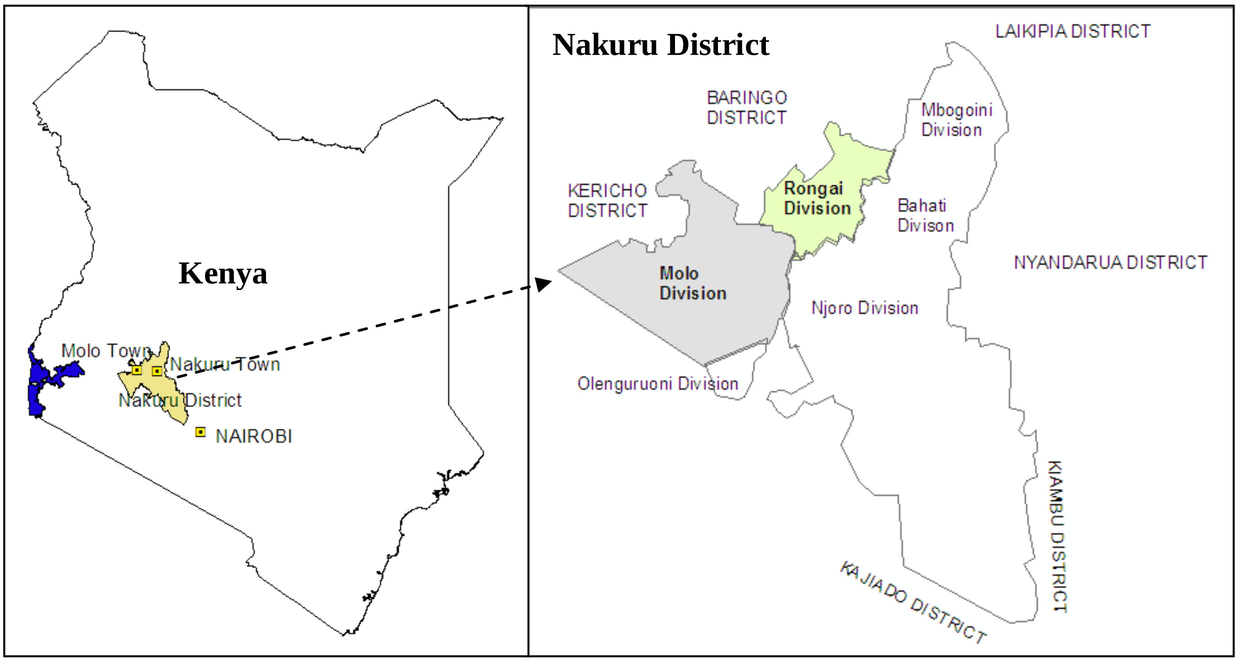

Figure 2: Location of the study area in Kenya

3.4 Study Population

The study targeted smallholder dairy households participating in the FFS and NFFS extension training approaches in Molo division. In this area, there are about 3000 smallholder dairy farmers out of which 200 had completed FFS training sessions by the end of 2005 and another 500 farmers had trained through the NFFS extension approach.

3.5 Sampling Procedure and Sample Size

A stratified random sampling technique with equal allocation in a cross sectional survey was applied, to obtain two strata (FFS and NFFS) on which the differences on the levels of knowledge and skills on the use and application of DMTs were evaluated. Ary *et al*. (1979) recommended equal allocation of subjects as most appropriate when characteristics of interest are for a particular stratum, which in this study correspond to examining the effects of FFS extension approach on farmers` knowledge and skills on the use of DMTs.

Lists of farmers participating in FFS and NFFS were obtained from the Molo Divisional

Livestock Extension Office and verified with another list from FFS co-ordinating office at International Livestock Research Institute (ILRI) in Nairobi. Using random number generator, 100 FFS were randomly selected from one stratum and another 100 NFFS from the next strata. However, only 94 FFS and 72 NFFS farmers were available for the interviews. The FFS farmers were drawn from six locations where FFS is currently operating while NFFS farmers were drawn from four locations where FFS has not been introduced to date in order to limit possibilities of exchanged extension messages between the FFS and NFFS farmers. The stratified random sampling applied ensured a more representative sample for the results to be inferred to a larger population (Ary *et al*., 1979).

The sample size drawn was considered adequate as per the recommendations of Kathuri and Pals (1993) that 100 subjects are sufficient for a cross sectional survey research study of this kind, allowing for respondents who may be unwilling to respond and possible cases of attrition.

3.6 The Instrument of Data Collection

Information necessary for testing the hypotheses of the study was collected using a structured questionnaire (Appendix 1), designed to measure the level of farmers' knowledge and skills on the use and application of various DMTs. Multiple response questions were formulated to measure the level of knowledge while Likert scale rating was applied in measuring the level of skills acquired on the use and application of DMTs of importance in both FFS and NFFS dairy extension services. Other information collected included farming systems and farmers` personal characteristics as moderator variables that potentially have influence on the level of farmers` knowledge and skills on the use and application of DMTs.

3.6.1 Validation of the Instrument

Validation of the structured questionnaire instrument used in this study involved seeking expert opinion of the faculty members, supervisors and peers from the Departments of Agricultural Education and extension and Animal Sciences of Egerton University. The study objectives and hypotheses together with their corresponding measurable variables formed the basis of validation. Incorporation of expert opinions to improve on the instrument ensured valid measurement of relevant variables for the stated objectives and hypotheses about the level of knowledge and skills farmers have about the selected DMTs. The goal of validation was to make the findings and inferences of the study appropriate, meaningful and useful following recommendations of Fraenkel *et al*. (1990) and Mugenda and Mugenda (1999).

3.6.2 Reliability of the Instrument

To ensure clarity and reliability, the instrument was pre-tested with 10 FFS and 10 NFFS trained smallholder dairy farmers randomly selected amongst those participating in the FFS and NFFS training extension approaches in Rongai division. This was a separate division from where the study was conducted. A list of FFS and NFFS participating farmers was obtained from the Divisional Livestock Extension Office. The 20 farmers selected were drawn from areas which had similar socio-economic and biophysical characteristics to those found in Molo division. Pre-testing enabled shortening of questions judged too long and improvement on clarity for questions that were judged ambiguous. In this study, reliability of the instrument for consistency was estimated using Cronbachs` alpha, which is appropriate for ascertaining both inter-item and inter-case consistency. The calculated alpha was 0.960, which was higher than the reliability coefficient threshold set a*priori* at 0.700 as recommended by Fraenkel and Wallen (1990).

3.7 Data Collection Procedure

A research permit was obtained from the Ministry of Education headquarters in Nairobi through the graduate school. The researcher personally administered the questionnaire to FFS and NFFS respondents who had to be the household member actively participating in the extension training sessions. The researcher explained to the respondent the purpose of the study before administering the questionnaire. The farmers' knowledge and skills on the use of DMTs were investigated to determine the influence of FFS when compared to NFFS extension training approach. Asking specific questions on critical aspects of DMTs usage tested farmers' knowledge about DMTs. The respondent was asked to choose only one of the four alternative responses that corresponded to their knowledge about an aspect of DMTs usage. Farmers responding correctly were classified knowledgeable while those responding incorrectly were classified not knowledgeable about the DMTs usage. Farmers' skills about DMTs were measured by asking farmers to rate their level of skill in using or applying an aspect of DMTs on a 4-point Likert scale (1= least and 4= highly skilled). All the responses were recorded in the questionnaire and then entered into an electronic database (SPSS version 11.5 software) for storage and analysis.

3.8 Data Analysis

The data was edited and cleaned to ensure correct entry of the responses before subjecting them to both descriptive and inferential statistical analysis for the study hypotheses outlined in Table 3. The proportions of farmers knowledgeable about use and application of DMTs were cross-tabulated then subjected to Cochran's and Mantel-Haenszel chi-square statistics to test for significant differences between the FFS and NFFS trained farmers. The analytical model accounted for the influence of moderating variables which included age, gender, marital status, educational level, source of income, farm size, herd size and milk market outlets. Farm size and herd size were categorised into two groups based on their median: ≤ median and >median. The median was used because the data distribution was skewed.

Farmers' skills on use of DMTs measured on Likert scale rating were subjected to non-parametric Mann-Whitney U test. Significant differences between FFS and NFFS trained farmers was detected by fitting rated skill as the dependent variable and extension approach (FFS and NFFS) together with the moderator variables as the independents.

Differences in dairy productivity measures between FFS and NFFS trained farmers were tested using the t-test because these were continuous variable measures from two independent samples. Data analysis used the statistical software SPSS version 11.5 and all statistically significant differences in the hypothesis testing were judged at 5% level of significance.

Table 3: Summary of hypothesises tested with their corresponding dependent and independent variables and the statistical analysis

Null Hypotheses	Independent variables	Dependent variables	Statistical tests
1. There is no statistically significant difference in knowledge and skills acquired on AI technology between farmers trained through FFS and NFFS extension approaches	Extension approach (FFS and NFFS)	Farmers' knowledge on use of AI technology	Chi-square tests
		Farmers' skills on use of AI technology	Non-parametric Mann-Whitney U test
2. There is no statistically significant difference in knowledge and skills acquired on calf rearing technology between smallholder farmers trained through FFS and NFFS extension approaches.	Extension approach (FFS and NFFS)	Farmers' knowledgeable on use of calf rearing technology.	Chi-square tests
		Farmers' skills on use of calf rearing technology	Non-parametric Mann-Whitney U test
3. There is no statistically significant difference in knowledge and skills acquired on dairy cow feeding technology between smallholder farmers trained through FFS and NFFS extension approaches.	Extension approach (FFS and NFFS)	Farmers' knowledge on use of dairy cow feeding technology.	Chi-square tests
		Farmers' skills on use of dairy cow feeding technology	Non-parametric Mann-Whitney U test
4. There is no statistically significant difference in knowledge and skills acquired on mastitis control technology between smallholder farmers trained through FFS and NFFS extension approaches	Extension approach (FFS and NFFS)	Farmers' knowledge on use of mastitis control technology	Chi-square tests
		Farmers' skills on use of mastitis control technology	Non-parametric Mann-Whitney U test
5. There is no statistically significant difference in knowledge and skills acquired on polythene tube silage making technology between smallholder farmers trained through FFS and NFFS extension approaches.	Extension approach (FFS and NFFS)	Farmers' knowledge on use of polythene tube silage making technology.	Chi-square tests
		Farmers' skills on use of polythene tube silage making technology	Non-parametric Mann-Whitney U test
6. There is no statistically significant difference in knowledge and skills acquired on napier fodder management technology between smallholder farmers trained through FFS and NFFS extension approaches.	Extension approach (FFS and NFFS)	Farmers' knowledge on use of napier fodder management technology	Chi-square tests
		Farmers' skills on use of napier fodder management technology	Non-parametric Mann-Whitney U test
7. There is no statistically significant difference in the level of dairy herd productivity achieved by farmers trained through FFS and NFFS extension approaches	Extension approach (FFS and NFFS)	Milk yield, Number of services per conception, body condition score	t –tests

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the description of household and farming characteristics with the discussion of results for each of the objective and hypothesis tested regarding the influence of the extension approach and moderating variables on knowledge and skills of the farmers about DMTs and productivity levels realised.

4.2 Household and Farming Characteristics of the Sample Population by Extension Approach

The household and farming characteristics of the sample population considered in the study included gender, age, highest level of education attained, marital status, source of income, farm size, herd size and milk market outlet.

4.2.1 Household characteristics by Extension Approach

Table 4 displays aspects of the household characteristics of the sampled smallholder dairy farmers by extension approach. The total sample size was 166 farmers, of which 94 were actively participating in FFS and 72 in NFFS extension training approaches.

Gender distribution was unequal ($p<0.05$) with males comprising more than half (65.1%) of the respondents and dominating in both extension approaches (56.4% of FFS and 76.4% of NFFS). However, FFS farmers had relatively better gender balance, reflecting deliberate attempts in FFS extension approach to achieve gender balance amongst the target beneficiaries. The marital status and source of income of these farmers was not different ($p>0.05$) between the two extension approaches.

There were more ($p<0.05$) farmers trained to the level of secondary and above amongst those participating in NFFS (38.9%) than in the FFS (25.8%) extension approach, implying that education may explain some differences in the acquired knowledge and skill about DMTs in this sample population.

About a third of the farmers (33 to 40%) had a farming experience of between 1-5 years, but their age groups were not uniform ($p<0.05$) between NFFS and FFS extension approaches. The most agriculturally active and productive age group (31-40 years) were more ($p<0.05$) amongst the NFFS than FFS participating farmers (25 vs 13.8%).

Table 4: Sample distribution in gender, education level, age, marital status and source of income by FFS and NFFS extension approaches

Household characteristics	FFS farmers (n=94)	NFFS farmers (n=72)	χ^2 value	df	p-value
Gender			7.178	1	0.007
Male (%)	56.4	76.4			
Female (%)	43.6	23.6			
Education			11.776	3	0.008
None (%)	10.7	6.9			
Primary (%)	63.8	54.2			
Secondary (%)	25.8	27.8			
Tertiary (%)	0.0	11.1			
Age (years)			9.905	4	0.042
<20 (%)	0.0	5.6			
21-30 (%)	7.4	8.4			
31-40 (%)	13.8	25.0			
41-50 (%)	27.7	23.6			
>50 (%)	51.1	37.5			
Marital status			2.796	2	0.247
Single	5.4	8.3			
Married	84.0	87.5			
Windowed	10.6	4.2			
Source of income			1.252	1	0.263
Farming	96.8	93.1			
Off-farm	3.2	6.9			

4.2.2 Farming characteristics by Extension Approach

Because farming characteristics represented by farm size, herd size and milk market outlets (hawking and processing) were generally skewed, they were categorised into:≤ median and >median for analysing proportional difference between the extension approaches. The median categories were not different ($p>0.05$) between the extension approaches, though on average, NFFS farmers owned larger ($p<0.05$) farm size (1.31 vs 1.09 ha) and larger ($p<0.05$) herd size (3.14 vs 2.59) compared to the FFS farmers (Table 5). Farm and herd sizes were positively and significantly correlated (Spearman correlation = 0.33; p-value= 0.005) for

NFFS farmers, but not for the FFS farmers, which suggests a tendency for larger herds in big farms and that FFS farmers were land resource poorer than the NFFS farmers. Results imply that FFS extension approach was better in targeting the resource-poor farmers, as reported by Minjauw *et al*. (2002).

Though the milk market channels used did not significantly differ, many of the FFS farmers tended to market their milk through the processors, implying some preference for formal marketing over informal marketing channels.

Table 5: Sample distribution in farm size, herd size and milk marketing outlets by FFS and NFFS extension approaches

Farming characteristics	FFS farmers (n=94)	NFFS farmers (n=72)	χ^2 value	df	p-value
Farm size			0.367	1	0.545
≤ Median	33.0	37.5			
> Median	67.0	62.5			
Herd size					
≤ Median	52.1	48.6	0.202	1	0.653
> Median	47.9	51.4			
Milk marketing outlets					
Informal through hawkers	34.1	45.5	1.553	1	0.213
Formal through processors	65.9	54.5			

4.3 Farmer Knowledge and Skills of dairy Management Technologies (DMTs) by Extension Approach

This study evaluated the influence FFS has had on farmers' knowledge and skills about the use and application of DMTs in Molo division where FFS has been applied in smallholder dairying. The hypothesis tested was that FFS and NFFS trained farmers were equally knowledgeable and skilled in the use and application of those DMTs. The analytical model fitted extension approach (FFS and NFFS) together with identified moderator variables as the independent variables and farmer's knowledge and skills as the dependent variables. In addition, the difference in the level of dairy herd productivity achieved between FFS and NFFS farmers was evaluated.

4.3.1 Farmer Knowledge and skills of Artificial Insemination (AI) Technology by Extension Approach

Table 6 summarises the Chi-square tests comparing the proportion of FFS and NFFS farmers knowledgeable about the use and application of AI technology when accounting for the influence of the moderating variables.

Table 6: Proportion of farmers (%) knowledgeable about AI technology use

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	**NFFS (n=72)**	**Ext**	**Ag**	**Ge**	**Ms**	**Ed**	**Inc**	**FZ**	**HZ**	**Mk**
Heat sign for highest chances of conception	73.4	46.5	***	*	*	NS	NS	NS	NS	NS	*
Managing a cow that take long to come on heat	91.5	71.8	**	NS	NS	NS	NS	NS	NS	NS	NS
How to monitor a cow to ensure good heat detection	52.1	39.4	NS	NS	NS	NS	NS	NS	NS	NS	NS
Criteria to use in deciding the right time to first serve heifers	81.9	36.6	***	NS	NS	NS	NS	NS	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001

Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

Farmers participating in the FFS were more (p<0.05) knowledgeable than those participating in the NFFS extension approach for most of the AI technology use and application tested, except for monitoring cows for general heat detection, The FFS farmers were more (p<0.05) knowledgeable about important heat signs enhancing highest chances of conception (73.4 vs 46.5%), appropriate management of a cow that has taken a long time to conceive (91.5 vs 71.8%) and the criteria for serving a heifer for the first time (81.9 vs 36.6%).

Except for age, gender and milk market outlets, other moderating variables had no influence on the knowledge gained by farmers on the use and application of the AI technology. The influence of age was observed for age group 41 to 50 years, where more FFS farmers had greater knowledge of AI technology than the NFFS farmers (31.9 vs 18.2%: χ^2 value of 11.008; p=0.001). The influence of age on knowledge relates to farmers being able to learn more effectively when they are within the same age group, as they tend to have similar interests and work together. This is in agreement with the explanation of Burkey (1996) and Van-de-Fliert (1993) that learning from each other strengthens farmers' capacity of working together and sharing information where agricultural activities are collectively carried out in groups, as is the practice in FFS extension approach.

Gender influence on knowledge was significant only amongst the male respondents, with males participating in the FFS demonstrating greater knowledge than those participating in the NFFS extension approach (86.8 vs 50.0%: χ^2 value of 16.702; p=0.000). This can be attributed to higher level of education amongst the male respondents, because more males compared to females had primary to tertiary education levels (96.3 vs 81.0%), which means that fewer males compared to females had no formal education (3.7 vs 19.0%).

The influence of milk market outlet was only observed in the formal market channel, with the FFS farmers being more knowledgeable than those in NFFS extension approach (75.9 vs 30.4%: χ^2 value of 14.218; p=0.000). This difference can be attributed to availability of marketable surplus milk evidenced with higher milk production levels by the FFS compared to the NFFS trained farmers (7.2 vs 5.6 litres of milk per cow per day).

On overall, results on knowledge about AI technology suggest that FFS was more effective than NFFS extension approach in disseminating more complex technological messages to farmers, corroborating observations made with sweet potatoes in the Peruvian Andes by Godtland *et al*. (2004) that FFS approach enhances farmers` knowledge of complex technical nature.

Table 7 presents the results of non- parametric Mann-Whitney U tests on Likert scale ratings of skills important for successful use and application of AI technology. The null hypothesis tested was rejected. For all aspects of AI technology investigated, farmers in FFS were more skilled than those in NFFS extension approach.

Table 7: Mean score rating (SD) for farmers` skills (1=lowest to 4=highest) in AI technology use by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ag	Ge	Ms	Ed	Inc	FZ	HZ	Mk
Detecting heat signs	2.99 ± 0.73	2.51 ± 0.82	***	NS	NS	NS	NS	*	NS	NS	NS
Determining insemination moment for highest chances of conception	2.81 ± 0.79	2.11 ±0.93	***	NS	NS	NS	NS	NS	NS	NS	NS
Managing a cow that has taken long to conceive	2.86 ± 0.68	1.96 ± 0.93	***	NS	NS	NS	NS	*	NS	NS	NS
Optimum moment to serve heifer for first time	2.97 ± 0.74	2.06 ± 0.73	***	NS	NS	NS	NS	NS	NS	NS	NS
Use dairy records for insemination decisions	2.35 ± 0.75	1.96 ± 1.01	***	NS	NS	NS	NS	NS	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001

Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

Comparatively, FFS farmers were better skilled (p<0.05) in determining the right time to inseminate a cow for highest chances of conception (2.81 vs 2.11) and in heat detection (2.99 vs 2.51). They were also better skilled in managing a cow that has taken a long time to come on heat (2.86 vs 1.96), determining the optimal time of inseminating heifers (2.97 vs 2.06) and keeping and using dairy records for insemination decisions (2.35 vs 1.96).

Except for the level of income, all the other moderator variables did not impact any influence (p>0.05) on skills that farmers acquired on use and application of AI technology. The level of income significantly influenced (p<0.05) the way farmers managed cows that take a long time to conceive and also on detection of heat signs. Consequently, farmers with high incomes could achieve shorter calving intervals in their herds.

That skills critical to successful use of AI technology rated higher amongst the FFS than the

NFFS farmers on all aspects tested suggests that FFS extension approach was more effective than NFFS in imparting production skills to farmers for AI technology. The FFS farmers may be more skilled in AI technology because of the more emphasis on experiential learning FFS extension approaches uses in contrast to the more emphasis on instructional mode of education of NFFS approach (Van de Fliert *et al*., 1993). Experience based learning empower people to actively solve the ensuing problems by fostering participation. Through empowerment, farmers learn to stand on their own and think for themselves, they learn to do their own observations on the cow, make their discoveries, make their own decisions and take action on their own.

4.3.2 Farmer Knowledge and skills about Calf Rearing Technology by Extension Approach

Results of Chi-square test comparing the proportion of FFS and NFFS farmers knowledgeable about aspects of calf rearing technology is presented in Table 8.

Table 8 Proportion of farmers (%) knowledgeable about calf rearing by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ag	Ge	Ms	Ed	Inc	FZ	HZ	Mk
Reasons for allowing calf free access to colostrum	85.1	80.6	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reasons for attaining recommended growth rate in calves	90.4	66.7	***	**	**	**	NS	***	NS	NS	NS
Diseases common in poorly housed calves	94.7	80.6	***	NS	NS	NS	NS	NS	NS	NS	NS
Recommendations for a good calf pen	44.7	61.1	*	NS	NS	NS	NS	NS	*	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001

Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

Compared to NFFS, more FFS farmers were knowledgeable (p<0.05) about what management practices would achieve high growth rate in calves (90.4 vs 66.7%), about common diseases in poorly housed calves (94.7 vs 80.6%), and about the requirements of a good calf pen (61.1 vs 44.7%). Results suggest that the FFS farmers were better empowered with knowledge on calf rearing than the NFFS farmers, except for knowledge on why calves are allowed free access to colostrum (85.6 vs 80.6%). These aspects of technology where FFS farmers were more knowledgeable than the NFFS farmers are generally more complex in nature, which suggests some advantages associated with FFS extension approach in effectively disseminating complex technologies.

The influence of moderator variables was more prominent on the knowledge about reasons for attaining recommended growth rate in calves. This is illustrated by farmers in the age group 41-50 years, and those participating in FFS were more knowledgeable than their NFFS counterparts (24 vs 8%, χ^2 value of 11.055, p= 0.001). The significance of gender influence was related to female FFS farmers being more knowledgeable than their NFFS counterparts (87.2 vs 12.8%, χ^2 value of 15.624, p=0.000). Married FFS farmers were more knowledgeable than ($p<0.05$) their NFFS counterparts (62.1 vs 37.9%, χ^2 value of 10.629, p= 0.001). For farmers relying on farm as a major source of income, FFS farmers were more ($p<0.05$) knowledgeable about the reasons for achieving high growth rates in calves than their NFFS counterparts (64.6 vs35.4%, χ^2 value of 12.883, p=0.000). These results reflect on one of the principles of FFS that experiential learning enhances farmers` knowledge in the use and application of agricultural technologies for production decisions.

Table 9 presents the results on farmers' rating of skills on aspects of calf rearing technologies. Skills in calf rearing technologies rated lower ($p<0.05$) for NFFS than for FFS farmers regarding managing a calf during the first week after birth (2.07 vs 2.72), achieving adequate calf growth rates (2.19 vs 2.74), detecting health problems in calves (2.26 vs 2.89), and maintaining good calf housing (2.17 vs 2.64).

Significant influence of moderator variables was only observed for income and farm size. For farmers relying on farm as a major source of income, FFS farmers were better skilled in achieving adequate growth rate in calves than ($p<0.05$) their NFFS counterparts (Mean score

2.74 vs 2.19, p-value= 0.032) and also better skilled in detecting health problems in calves than (p<0.05) their NFFS counterparts (Mean score 2.65 vs 2.13, p-value = 0.008). Cash availability enables farmers to adopt recommended interventions, which reflects the importance of farmers having access to cash in the adoption of production technologies.

Table 9 Mean score rating (SD) for farmers` skills (1=lowest level to 4=highest level) in calf rearing technology by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ag	Ge	M s	Ed	Inc	FZ	HZ	Mk
Managing a calf during the first week after birth	2.72 ± 0.71	2.07 ± 0.83	***	NS	NS	NS	NS	NS	NS	NS	NS
Achieving adequate growth rate in calves	2.74 ± 0.64	2.19 ± 0.87	***	NS	NS	NS	NS	*	NS	NS	NS
Detecting health problems in calves	2.89 ± 0.60	2.26 ± 0.82	***	NS	NS	NS	NS	**	*	NS	NS
Maintaining good housing conditions for calves	2.64 ± 0.73	2.17 ± 0.95	***	NS	NS	NS	NS	*	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001

Ext – Extension approach, **Ag** = Age **Ge** =Gender; **Ms** = Marital status; Ed = Educational level; **Inc** = Income source; FZ = Farm size; **HZ** = Herd size; Mk = Milk market outlets

Farmers whose farms were of below the median size were better (p<0.05) skilled in detecting health problems in calves than their NFFS counterparts (mean score 1.312 vs 1.095; p-value= 0.011) and also better (p<0.05) skilled in maintaining good housing conditions for calves than their NFFS counterparts (mean score 1.97 vs 1.93, p-value= 0.041). The results generally suggest that FFS extension approach enhanced uptake of relevant calf rearing interventions by smallholders and more so when endowed with resources thereby enabling farmers to respond appropriately to the constraints faced in rearing good quality dairy calves.

4.3.3 Farmer Knowledge and Skills about Dairy Cow Feeding Technology by Extension Approach

Results of Chi-square tests comparing the proportion of FFS and NFFS farmers knowledgeable about aspects of dairy cow feeding technology are presented in Table 10.

There were more ($p<0.05$) FFS than NFFS farmers knowledgeable about what a balanced dairy cow ration should comprise (94.7 vs 77.9%) and the alternative sources of protein other than concentrates (91.5 vs 61.1%).

Table 10: Proportion of farmers (%) knowledgeable about dairy cow feeding technologies by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	**NFFS (=72)**	**Ext**	**Ag**	**Ge**	**Ms**	**Ed**	**Inc**	**FZ**	**HZ**	**Mk**
Balanced ration for a dairy cow	94.7	77.8	**	NS	NS	NS	NS	NS	NS	NS	NS
Stage of lactation critical for feeding adequate balanced ration	48.9	33.3	NS	NS	NS	NS	NS	NS	NS	NS	NS
Alternative protein sources other than concentrates	91..5	61.1	***	*	NS	NS	NS	NS	NS	NS	**

NS is not significant at $p>0.05$, * = $p<0.05$, ** = $p< 0.01$; *** = $p< 0.001$

Ext – Extension approach, **Ag** = Age; Ge =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

The moderator variables with significant influence on farmers` knowledge of dairy cow feeding technology were age of the farmer and milk market outlet used. The influence of age was detected for those in the age group 41-50 years in which the FFS farmers were more ($p<0.05$) knowledgeable about alternative protein sources other than concentrates when compared to their NFFS counterparts (51 vs 14%; χ^2 value of 13.108; p= 0.000). When formal milk outlet is used, the FFS trained farmers were more ($p<0.05$) knowledgeable on alternative protein sources than their NFFS counterparts (51 vs 14%; χ^2 value of 13.108; p= 0.000). The results suggest that experience and a reliable source of milk market directly influences farmers` knowledge on dairy feeding technology.

Results on skills were consistent with those of knowledge, with higher rating of technological skills ($p<0.05$) for the FFS than NFFS farmers (Table 11) on making a balanced dairy cow ration (3.00 vs 1.96), feeding a dairy cow to its` nutritional requirements (2.72 vs 1.90) and feeding alternative supplements rather than dairy meal (3.00 vs 1.82). The FFS farmers were also better ($P<0.05$) skilled in interpreting and appropriately using the label information given by feed manufacturers (2.59 vs 1.61). Income directly influenced farmers` skills of feeding a dairy cow to its` nutritional requirements since some nutritional supplements were commercially sourced. These results illustrate superiority of FFS over NFFS extension approach in disseminating technological skills necessary for good dairy cow feeding.

Table 11: Mean score rating (SD) for farmers` skills in dairy cow feeding technology by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS(n=94)	NFFS (n=72)	Ext	Ag	Ge	Ms	Ed	Inc	FZ	HZ	Mk
Making a balanced dairy cow ration	3.00 ±053	1.96.± 0.90	***	NS	NS	NS	NS	NS	NS	NS	NS
Feeding a cow to nutritional requirements	2.72±0.74	1.90 ± 0.88	***	NS	*	NS	NS	*	NS	NS	NS
Feeding alternative feeds to dairy meal	3.00±0.64	1.82 ± 0.88	***	NS	NS	NS	NS	NS	NS	NS	NS
Interpreting and appropriately using the label information given by feed manufacturers	2.59 ± 0.73	1.61 ± 0.88	***	NS	NS	NS	NS	NS	NS	NS	NS

NS is not significant at $p>0.05$, * = $p<0.05$, ** = $p< 0.01$; *** = $p< 0.001$

Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

4.3.4 Farmer knowledge and skills about Management of mastitis by extension approach

Results of Chi-square tests comparing the proportion of FFS and NFFS farmers knowledgeable about causes, diagnosis, control and management of mastitis infected cows are presented in Table 12.

For all the examined aspects of mastitis management technology, a larger proportion of FFS than NFFS farmers were more ($p<0.05$) knowledgeable about causes of mastitis (98.9 vs

77.1%), management routines for detecting mastitis (56.4 vs 34.3%) and managerial actions when mastitis infection is detected (93.6 vs 82.6%). However both extension approaches equally disseminated to farmers the knowledge of classical signs of a cow infected with mastitis (80.9 vs 74.3) which is associated with easy to observe changes in smell, appearance of clots, blood or colour in milk. That the FFS was a better approach at enhancing farmers` knowledge of technologies requiring more complex technical knowledge is demonstrated here and concurs with reports of Godtland *et al*., (2004).

Table 12: Proportion of farmers (%) knowledgeable about management of mastitis by extension approach.

Technology aspect tested	**Extension approach (Ext)**		**Significance of the independent variables**								
	FFS (n=94)	**NFFS (n=72)**	**Ext**	**Ag**	**Ge**	**Ms**	**Ed**	**Inc**	**FZ**	**HZ**	**Mk**
Causes of frequent mastitis in herd	98.9	77.1	***	NS	NS	NS	NS	NS	NS	NS	NS
Management routines for detecting mastitis in herd	56.4	34.3	**	NS	NS	NS	NS	NS	NS	NS	**
Classical signs of a cow infected with mastitis	80.9	74.3	NS	NS	NS	NS	NS	NS	NS	NS	NS
Managerial action when mastitis infection is detected	93.6	82.6	*	*	NS	NS	*	NS	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001
Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

The moderator variables with significant influence on farmers` knowledge about the management routines for detecting mastitis in the herd were education level, age and milk market outlet used. For farmers marketing milk through formal market channels, the FFS farmers were more (p<0.05) knowledgeable than their NFFS counterparts (41.7 vs 58.3%, χ^2 value of 5.486, p=0.02) because formal markets reject mastitis infected milk and farmers learn quickly on how to avoid losses arising from milk rejection. Amongst farmers with primary to tertiary levels of education, the FFS farmers were more (p<0.05) knowledgeable than their NFFS counterparts (90 vs 10%, χ^2 value of 7.350, p=0.017). Significant influence of age on farmers` knowledge was observed within the age group of 41-50 years with FFS trained farmers coming out more knowledgeable than their NFFS counterparts (66.7 vs33.3%,χ^2 value of 5.250, p=0.049).

The effectiveness of FFS trained farmers in control of mastitis can be attributed to the principle of learning by discovery promoted and sustainable practices by farmers that have been associated with the FFS extension approach (Van de Fliert, 1993). With FFS, various activities and experiments are organized so that farmers can experiment by themselves. Farmers are practically taught disease symptoms, causes, predisposing factors and the options controlling infections. These effectively impart knowledge and skills to farmers enabling them to use, apply or implement technologies for the management of mastitis infections.

Farmers self rated skills in managing mastitis infections are displayed in Table 13. The corresponding statistical testing of the null hypothesis was rejected. Results suggest that the FFS farmers had become better ($p<0.05$) skilled than NFFS farmers in preventing mastitis infection (3.01 vs 2.42), detecting mastitis infection (2.88 vs 2.38), and managing a cow infected with mastitis (2.91 vs 1.63). A technological aspect in which both FFS and NFFS were equally ($p>0.05$) skilled was the of use mastitis detecting equipment (2.15 vs 2.04). This is largely attributed to the fact that farmers in Molo (both FFS and NFFS) do not use the equipment. Instead, they use alternative methods of detecting mastitis such as milk clotting, smell and change in milk colour. There is scope in the use of FFS diagnostic procedures to enhance farmers' capacity to use the mastitis detection equipment or its cheaper and locally available alternatives.

All the moderator variables investigated had no significant influence ($p>0.05$) on farmers skills on use and application of mastitis management technologies, which is akin to earlier observations by Van-de Fliert *et al.* (1999) that farmers trained through FFS understood better the concept of pest control and do thorough field observation than those trained through NFFS extension approaches. Godtland *et al.* (2004) made similar observations that FFS trained farmers effectively controlled late blight in sweet potatoes in the Green Andes of Peru than the NFFS group. Similarly farmers trained in the control of mastitis take closer observation of the cow, and apply appropriate and practical measures to manage the infection.

Table13: Mean score rating (SD) for farmers` skills (1=lowest level to 4=highest) in mastitis management technology use by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ge	Ag	Ms	Ed	Inc	FZ	HZ	Mk
Preventing mastitis from herd	3.01 ± 0.60	2.42 ± 0.93	***	NS	NS	NS	NS	NS	NS	NS	NS
Detecting mastitis infection	2.88 ± 0.69	2.38 ± 0.90	***	NS	NS	NS	NS	NS	NS	NS	NS
Using mastitis detecting equipment	2.15 ± 0.69	2.04 ± 0.90	NS	NS	NS	NS	NS	NS	NS	NS	NS
Managing a cow infected with mastitis	2.91 ± 0.68	1.63 ± 0.94	***	NS	NS	NS	NS	NS	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001

Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

4.3.5: Farmers knowledge and skills about Napier Grass Fodder Management by Extension approach

Napier grass is a major feed resource in smallholder dairy production systems. Chi-square tests comparing the proportion of FFS and NFFS farmers knowledgeable about technology aspects essential for napier grass management is presented in Table 14. Generally, more FFS ($p<0.05$) than NFFS farmers were knowledgeable about the recommended legumes to intercrop with napier grass fodder (88.3 vs 58.3%), the optimum recommended height at which napier grass is cut (62.8 vs 48.6%) and the suitable planting materials to use when establishing napier grass (95.7 vs 83.3%). There was no difference ($p>0.05$) in knowledge acquired between the FFS and NFFS trained farmers about the number of cows that can be maintained with one acre of napier grass fodder (60.6 vs 39.4%) and the correct spacing in napier grass planting (68.1 vs 56.6%). Owing to small farm sizes and high levels of precipitation in the study area, farmers (both FFS and NFFS) have a tendency of maximizing space utilization and so do not follow recommended spacing for napier grass. In Molo, the farmers also do not rely solely on napier grass in dairy cattle feeding. They complement it with Stover, maize thinning and stripping, crop residues and roadside grazing, which may explain the lack of significant influences in the number of dairy cows supported by 1 acre of napier grass.

It is significant to note that none of the moderator variables investigated had significant influence (p>0.05) on farmers' knowledge about the napier fodder management technologies.

Table 14: Proportion of farmers (%) knowledgeable about napier grass management technologies.

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	NFFS(n=72)	Ext	Ag	Ge	M s	Ed	Inc	FZ	HZ	Mk
Spacing for establishment of napier grass	68.1	56.6	NS	NS	NS	NS	NS	NS	NS	NS	NS
Optimum height to cut napier grass	62.8	48.6	***	NS	NS	NS	NS	NS	NS	NS	NS
Legume to intercrop with napier grass successfully	88.3	58.3	***	NS	NS	NS	NS	NS	NS	NS	NS
Planting material for establishment of napier grass	95.7	83.3	**	NS	NS	NS	NS	NS	NS	NS	NS
Number of cows to be supported by one are of napier grass	60.6	39.4	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001
Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

Table 15 shows that compared to NFFS farmers, FFS farmers skills rated higher (P<0.05) in selecting good napier planting materials (3.06 vs 2.64), in intercropping napier grass with legumes (2.86 vs 1.98) and in using right forage material for silage making (2.94 vs 2.06). The FFS trained farmers expressed more confidence in napier grass management skills (2.98 vs 2.56), suggesting that a participatory approach where farmers learn through facilitation rather than the instructional mode of NFFS approach enhances better uptake of skills essential for napier grass management.

Of the moderator variables tested, only source of income had significant influence on farmers` skills. Farm as source of income as opposed to off farm employment significantly ($p<0.05$) influenced farmers` skills on the management of napier grass (mean score 2.82 vs 2.25, $p=0.019$), selecting appropriate napier grass planting material (mean score 2.91 vs 2.38, $p=0.032$) and using the right forage material for silage making (mean score 2.57 vs 2.25, $p=0.007$). Napier management tend to be labour intensive and require some income in order to be implemented, hence high resource endowment influences the uptake of technologies related technologies.

Table 15: Mean score rating (SD) for farmers` skills in napier fodder management technology by extension approach

Technology aspect tested	Extension approach (Ext)		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ag	Ge	M s	Ed	Inc	FZ	HZ	Mk
Napier grass management	2.98 ± 0.66	2.56 ± 1.05	**	NS	NS	NS	NS	*	NS	NS	NS
Intercropping napier with legume	2.86 ± 0.80	1.98 ± 1.01	*	NS	NS	NS	NS	NS	NS	NS	NS
Selecting napier planting material	3.06 ± 0.69	2.64 ± 1.00	***	NS	NS	NS	NS	*	NS	NS	NS
Using right forage material for silage making	2.94 ± 0.69	2.06 ± 0.96	***	NS	NS	NS	NS	**	NS	NS	NS

NS is not significant at $p>0.05$, * = $p<0.05$, ** = $p< 0.01$; *** = $p< 0.001$

Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

4.3.6: Farmers' knowledge and skills about Polythene Tube Silage Making (PTSM) Technology by Extension approach

Chi-square tests comparing the proportion of FFS and NFFS farmers knowledgeable about essential aspects of Polythene Tube Silage Making Technology (PTSM) are presented in Table 16. A larger ($p<0.05$) proportion of the FFS than NFFS farmers knew of the right stage of ensiling green forage for optimum silage making (93.6 vs 73.8%). In addition a larger ($P<0.05$) proportion of the FFS than NFFS trained farmers knew of the forage materials unsuitable for silage making (93.6 vs 63.1%) and the desirable qualities of forage for good silage making (75.4 vs 37.2%). More (P<0.05) of FFS than NFFS farmers knew of why forages are chopped before ensiling (88.3 vs 47.7%), but interestingly both of these farmer groups were equally knowledgeable about the right mixing ratio of molasses to water used in silage making (9.4 vs 8.5%) which can be attributed past experiences in the use of molasses on maize stovers. Farmers marketing milk through the formal markets were more (p<0.05) knowledgeable than were the NFFS counterparts (85.2 vs 14.8% χ^2 value of 18.115, p=0.000) about reason for chopping silage before ensiling.

Table 16: Proportion of farmers (%) knowledgeable about polythene tube silage making

Technology aspect tested	Extension approach		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ag	Ge	M s	Ed	Inc	FZ	HZ	Mk
Stage of ensiling green forage for optimum silage making	93.6	73.8	**	NS	NS	NS	NS	NS	NS	NS	NS
Material not suitable for silage making	93.6	63.1	***	NS	NS	NS	NS	NS	NS	NS	NS
Reason for not using such unsuitable material	75.4	37.2	***	NS	NS	NS	NS	NS	NS	NS	NS
Ratio of molasses to water for silage making	9.4	8.5	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reason for chopping silage before ensiling	88.3	47.7	***	NS	NS	NS	NS	NS	NS	NS	**

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001
Ext – Extension approach, Ag = Age; Ge =Gender; Ms = Marital status; Ed = Educational level; Inc = Income source; FZ = Farm size; HZ = Herd size; Mk = Milk market outlets

Table 17 shows influence of extension approach and moderator variables on farmers' skills for use and application of PTSM. Results demonstrate the superiority (p<0.05) of FFS over NFFS on skills necessary for use and application of PTSM, which should enhance the capacity of FFS trained farmers in producing surplus marketable milk . FFS farmers were better (p<0.05) skilled than the NFFS farmers in the processes involved in PTSM (2.74 vs 1.74), optimum stage at which to ensile forage material (2.97 vs 2.56), using correct mixing ratios of molasses to water in silage making (2.84 vs 1.65), and the proper compaction of silage material (2.97 vs 1.97). These results are in agreement with the explanations advanced by Van de Fliert (1993) that collective performance of activities as in the FFS extension training sessions arouse farmers` interests, thereby enabling them to develop self confidence to experiment on their own.

Table 17: Mean score rating (SD) for farmers` skills (1=lowest, 4=highest) in polythene tube silage making technology use by extension approach

Technology aspect tested	Extension approach		Significance of the independent variables								
	FFS (n=94)	NFFS (n=72)	Ext	Ag	Ge	M s	Ed	Inc	FZ	HZ	Mk
Polythene tube silage making	2.74 ± 0.88	1.74 ± 0.96	***	NS	NS	NS	NS	NS	NS	NS	NS
Optimum stage to ensile forage material	2.97 ± 0.85	2.56 ± 0.98	***	*	NS	NS	NS	*	NS	NS	NS
Properly mixing molasses with water	2.84 ± 0.85	1.65 ± 0.98	***	NS	NS	NS	NS	NS	NS	NS	NS
Compacting forage for silage making	2.97 ± 0.78	1.97 ± 1.05	***	NS	NS	NS	NS	NS	NS	NS	NS

NS is not significant at p>0.05, * = p<0.05, ** = p< 0.01; *** = p< 0.001
Ext – Extension approach, **Ag** = Age; **Ge** =Gender; **Ms** = Marital status; **Ed** = Educational level; **Inc** = Income source; **FZ** = Farm size; **HZ** = Herd size; **Mk** = Milk market outlets

The moderator variables with significant influence on farmers` skills on PTSM technology were age and source of income. A higher proportion of farmers in age category of 41 and above were better skilled about the optimum stage to ensile forage material during polythene tube silage making process.. Most of the stages in polythene tube silage making are practical in nature and the older age group may have acquired relevant experience over the time of repeated use of PTSM. For farmers relying on the farm as their major source of income, the FFS were better skilled than their NFFS counterparts about the optimum stage to ensile a forage material (mean score 2.56 vs 2.50, p = 0.043). Some requirements for PTSM have to be acquired commercially thus income plays a significant role on adoption of PTSM interventions.

4.4 Dairy Herd Productivity and Milk Marketing by Extension Approach

Table 18 shows the level of dairy productivity for farmers trained through FFS and NFFS extension approaches. The FFS farmers achieved better ($p<0.05$) herd performance in terms of milk yield per cow per day and the number of services per conception but not ($p>0.05$) the body condition of the cow. Milk yield was 36% higher ($p<0.05$) for herds owned by FFS farmers compared to those of NFFS farmers. That body condition was not different between the two extension approaches may suggest that both still experienced inadequate quantity and quality feeding given the scarcity of feed resources and general low levels of income to enable farmers access commercial feeds. These results generally show that enhanced knowledge and skills about the dairy management technologies results into increased dairy herd productivity.

Table 18: Average milk yield, number of services per conception and cow body condition score by FFS and NFFS extension approaches in Molo division

Productivity measure	Farmers	Cows sampled (n)	Mean (SD)	Mean difference	t-test-p-value
Milk yield (l/d/cow)	FFS	90	7.2 (5.7)	1.94	0.020
	NFFS	60	5.3 (4.6)		
Number of service per conception (n)	FFS	90	1.0 (0.7)	0.28	0.002
	NFFS	60	1.1 (0.9)		
Cow body condition (1=poorest, 5= excellent)	FFS	90	3.9 (0.5)	0.07	0.602
	NFFS	60	3.6 (0.1)		

4.5 Summary of the Main Findings

Results of this study generally show that FFS extension approach enhanced acquisition of knowledge and skills about the DMTs more effectively compared to NFFS and encouraged a more gender balance in its` training programmes. Therefore FFS extension approach is better suited for the training of smallholder farmers who are resource poor.. The influence of income levels, age group, formal education, and milk marketing channels on the knowledge and skills that farmers acquired about DMTs, suggest that these factors would accelerate acquisition of knowledge and skills by farmers to some extent, especially for the more complex knowledge and skills.. Compared to NFFS participating farmers, the more effective dissemination of knowledge and skills through FFS enabled FFS participating farmers achieve higher dairy herd productivity levels. This is attributable to FFS extension approach enhancing the capacity of smallholder farmers to realise increased dairy herd productivity. And encourage farmers to market their milk through the formal milk market channels.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study, the conclusions drawn and recommendations given based on the key findings presented in the previous chapters.

5.2 Summary

The Farmer Field School (FFS) extension approach was initially conceptualised to enhance knowledge and skills in management of crops, crop pests, soil and water conservation technologies for which it has had proven successes (Minjauw *et al*., 2003). To replicate its successes, FFS was extended to dairy production for smallholder farmers as an alternative to the conventional extension approaches (NFFS), which had proved ineffective in enhancing necessary farmer knowledge and skills for dairy management technologies (DMTs) in Molo division. However many management aspects of crops, crop pests, soil and water conservation are not similar to those used in dairy production, which raises the question as to whether those successes of FFS can be replicated successfully in disseminating DMTs in smallholder dairy production systems.

This study aimed at gaining insights into the influence FFS extension approach has had on farmers' acquisition of knowledge and skills essential to enhancing dairy herd productivity. The conceptual framework was based on a modified version of the Hackman`s normative theory that emphasizes on group effectiveness and technology transfer approach as a prerequisite to technology adoption. The knowledge test and skills assessment was based on the FFS curriculum, similar to the one in which the NFFS farmers had also undergone through conventional extension approaches.

The sample population was selected through a stratified random sampling cross-sectional survey technique that obtained 94 FFS and another 72 NFFS farmers in Molo division.. Data collection was done with a structured questionnaire containing items on knowledge and skills on use and application of aspects of DMTs. The DMTs included Artificial insemination (AI), Calf rearing, Dairy cow feeding, control of Mastitis, Silage making and management of Napier grass fodder. The questionnaire's reliability was assessed for ease of comprehension and clarity using the Cronbach`s alpha. Its` validation was through intense discussions and modifications by peers and faculty experts. Knowledge was measured on ability to correctly answer a question on use aspect of DMTs from a-4 multiple-choice answers. Farmers self-rated their skills in use and application of DMTs aspects on a 4-point Likert scale (1= least, 4= highly skilled).

The hypothesis tested at 5% level of significance was that there is no statistically significant difference in knowledge and skills acquired on DMTs between farmers trained through the FFS and NFFS extension approaches under smallholder dairying conditions in Molo division. FFS extension approach and some identified moderator variable were the independents with farmers' knowledge and skills as the dependent variables.. Chi-square test was used to compare the proportion of FFS and NFFS farmers knowledgeable about use and application of DMTs, and non-parametric Mann-Whitney U tests compared Likert-scale rated skills while t-test was used to compare dairy productivity levels between FFS and NFFS farmers.

Results of this study generally showed that FFS extension approach enhanced acquisition of knowledge and skills about the DMTs more effectively compared to NFFS and encouraged a more gender balance in its` training programmes. Therefore FFS extension approach is better suited for the training of smallholder farmers who are resource poor. The influence of income levels, age group, formal education, and milk marketing channels on the knowledge and skills that farmers acquired about DMTs, suggest that these factors would accelerate acquisition of knowledge and skills by farmers to some extent, especially for the more complex knowledge and skills.. Compared to NFFS participating farmers, the more effective dissemination of knowledge and skills through FFS enabled FFS participating farmers achieve higher dairy herd productivity levels. This is attributable to FFS extension approach enhancing the capacity of smallholder farmers to realise increased dairy herd productivity. And encourage farmers to market their milk through the formal milk market channels.

The findings of the study are valuable reference to extension agents, farmers, agricultural and livestock policy makers, extension delivery systems and researchers in future design of effective dissemination approaches for DMTs targeting smallholders. It provides an objective basis for decisions to promoting and adopting FFS extension approach and re-evaluation of future development and packaging of technologies for enhanced adoption by the target beneficiaries.

5.3 Conclusions

The main conclusions drawn from the study are listed below:

1. Participation by smallholder dairy farmers in FFS training sessions significantly enhanced their knowledge and skills of DMTs. This training was found, by the study, to have enhance the farmers' knowledge and skills in the following DMTs; AI, calf rearing, dairy cow feeding, management of mastitis, management of napier fodder and polythene tube silage making. Results of data analysis support the conclusion of FFS enhancing farmers` knowledge and skills of dairy management technologies.
2. FFS extension approach increases the smallholder farmers` dairy herd productivity as a result of improved knowledge and skills in DMTs. This is also because FFS develops farmers` ability to make critical and informed decisions that renders smallholder dairy production systems more productive and profitable.
3. Participation by smallholder dairy farmers in FFS training sessions brings about concrete changes in their dairy production practices. As a result of experiential learning and experimentation, repeated exposure to a procedure enables the farmers to internalize and try out the practices on their own in their farms.
4. Since farm size and herd size of smallholder farmers have no effect on knowledge acquired and skills gained, it is therefore concluded that Dairy FFS is a better extension approach for empowering the resource poor and lowly educated smallholder dairy farmers than the conventional extension approaches. This is because; despite having relatively smaller farm and herd sizes than non FFS farmers trained using FFS acquired more knowledge and skills in the DMTs.
5. Approaches like FFS that are bottom-up, interactive and promoting learning by doing increases smallholder dairy farmers` capacity to gain knowledge and skills about various dairy management technologies. This generally implies that the FFS extension approach is better at empowering farmers with the knowledge and skills than the conventional extension approaches. An extension approach like FFS that involves farmers at all stages of learning is better at empowering smallholder dairy farmers with knowledge and skills of managing their own production problems.
6. FFS enhances farmers` learning of DMTs that are qualitatively and quantitatively more complex in nature and whose response to treatments takes a relatively longer time to be observed.

5.4 Recommendations

The following recommendations have been suggested from the findings and conclusions of the study.

1. Since FFS was introduced to smallholder dairy farmers in 2001, it means that the knowledge test and skills assessment was done not so long after the training sessions. This study therefore recommends resurveying of the participants after time has elapsed to confirm whether smallholder dairy FFS would impart lasting knowledge and skills of dairy management technologies as reflected in improvements in their conditions such as household income and food security. Since the acquired skills may not immediately result into changed practices, resurveying after time has elapsed would confirm whether the benefits in terms of milk production, other aspects of dairy herd productivity and income would grow.
2. Extension service providers and policy makers should consider adapting and mainstreaming dairy FFS extension approach for up-scaling of dairy management technologies in the smallholder farming systems of Kenya.
3. The public extension service should consider promoting some dairy FFS graduating farmers as facilitators to complement public extension at such times when Government resources are limited. To enhance the effectiveness of farmer trainers, the government should consider further training of farmer facilitators on group leadership and facilitation skills. This is important since it will complement government dwindling support in terms of personnel and working resources.
4. Further and focused follow-ups on farmer-led dairy FFS should be enhanced to monitor their performance and effectiveness. This would assist to monitor the dairy FFS influence on farmer knowledge and skills and subsequent sustainability. This is important, as it will enable farmers and facilitators address emerging issues affecting dairy production.
5. Further research should be undertaken to establish the effect of dairy FFS on technological aspects that are potentially riskier to undertake. This will enable extension agents and policy makers to plan for approaches that can enhance smallholders` capacity to experiment and learn about the potentially risky aspects with any deleterious effects on dairy herd.
6. It is not clear whether the benefits of dairy FFS` knowledge, skills and increased dairy herd productivity could justify the costs incurred in implementing various dairy technological options. There is need for a cost benefit analysis of the

extension approach as used in the dairy sub-sector.

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APPENDICES

APPENDIX A: SKILLS AND KNOWLEDGE MEASUREMENT QUESTIONNAIRE FOR SMALLHOLDER DAIRY FARMERS

Section A: Farmer personal characteristics and General Information

1. Date of interview: ………… Case No: …………… Location: ……………
2. Gender of respondent: Male 1 ☐ Female 2 ☐
3. Age of respondent in years: Below 20 ☐ 21-30 ☐ 31-40☐ 41-50☐ above 50 ☐
4. Marital status: Widow ☐ Married ☐ Single ☐ No response ☐
5. Highest educational level: None ☐ Lower primary ☐ Upper-primary☐
   Secondary ☐ Tertiary ☐
6. Do you belong to an FFS? Yes ☐ No ☐
7. What is the name of your FFS? Nyakinyua ☐ Mona ☐ Josiri ☐
   Mwangaza ☐ Mau summit ☐ Kiambiriria ☐
8. What is your main occupation Farmer ☐ Teacher ☐
   Civil servant ☐ Small business ☐ others (specify)……………………….
9. What is your major source of income? Off-farm employment ☐ Farming ☐
   other ☐ (specify). …………………………………
10. What is your farm size in acres? ………………………………..
11. What is your herd size in numbers? ……………………………
12. Number of years of experience in dairy production? …………..
13. What is your source of technical information in dairy production? FFS ☐ Extension
    ☐ FFS ☐ None ☐
14. Do you receive any extension service? 1 No 2 Rarely 3 Frequently 4 Very frequently
15. What is your average daily milk production in litres?
16. Do you sell milk? Yes ☐ No ☐
17. 17 Please indicate your milk market outlet ☐ KCC ☐Lelkina ☐ Spin Knit ☐
    Hawking ☐ Local vendors ☐ Other (specify) ☐

How much milk do you sell daily? <3 ☐ 3-6 ☐ 7-10☐ >10☐

19 What is the average price of milk per litre in Ksh?

20 Please indicate the type of milk records you keep

Milk production ☐ Breeding ☐ Herd health ☐ Milk sales ☐ routine management ☐ others (specify)……………………………..☐

21 Please indicate your general annual income level (Ksh) <5000 ☐ 5,000-

20000☐ >20,000-40,000 ☐ >40000-60000 ☐ >60000 ☐

SECTION B: Dairy Management Knowledge Test Questionnaire

The following questions concern knowledge of various dairy management technologies. Please choose one option reflecting your knowledge of the various aspects of dairy management technologies.

A. A.I Technology

I Which heat sign do you look for in order to achieve higher chances of conception on insemination?

1 Viscous clear vaginal discharge appearing
2 A cow walking away when mounted
3 A cow standing on being mounted by others
4 Sudden drop in milk production

II Which managerial action would you take for a cow that takes a long time to come on heat?

1 Withdraw the regular supply of mineral salts
2 Offer silage and minerals to the cow
3 Offer unlimited quantity of green forages, dairy meal, minerals and clean water
4 Just offer unlimited quantity of dairy meal

III How do you monitor your dairy cow to ensure good detection of heat signs when it comes on heat?

1 Rely on my herdsboy to observe the heat signs
2 Frequently look for heat signs amongst the cows
3 Keep records of all inseminations and identify those expected to show heat for close watch.
4 Look for cows mounting others.

IV Which criteria do you rely on when deciding when to serve a dairy heifer for the first time?

1. Season of the year
2. Body size of the heifer
3. Age and body size of the heifer
4. Age of the heifer

B. Calf rearing technology.

I Why must calves be allowed free access to colostrum?

1. The calf will die.
2. Calf will have poor feeding habits.
3. Calf will always be infected with diseases weakly and grow slowly.
4. Calf will delay first time feeding on grass.

II. What should farmers do to have their calves attain good growth rate?

1 Graze them with small ruminants.

2 Supply them with good quality forages and protect them from diseases.

3 Give it enough quantity and quality forages, minerals, housing and water.

4 House them individually

III. Which of the diseases is common in calves that are poorly housed?

1. ECF
2. Anaplasmosis.
3. Pneumonia.
4. Anthrax.

IV. Which of the following is recommended for calf pen?

1. Calf pen should be spacious and accommodate small ruminants.
2. Calf pens should be close to where the mature cows are housed.
3. Calf pen should be well ventilated and away from where mature cows are housed.

4 Close to the milking parlour.

C. Dairy cow feeding technology.

I. What does a balanced ration for a dairy cow contain?

1. Napier grass.
2. Dairy meal and Rhodes grass.
3. Lucerne, napier grass, dairy meal, dairy lick.
4. Dairy meal and minerals.

II At what stage of lactation does a cow critically need adequate balanced ration?

1 First eight weeks of lactation.

2 Last four weeks of lactation.

3 First half of lactation period.

4 Entire lactation period.

III What can you use in your dairy cow feeding to increase protein supplies and reduce need for supplementary concentrates?

1. Napier grass
2. Kikuyu grass
3. Lucerne
4. Sudan grass

D. Management of mastitis

I Which of the following will cause frequent mastitis cases in the herd?

1. Changing of milking time and personnel.
2. Milking without milking jelly.
3. Dirty milkman, milking containers and milking area incomplete milking.
4. A cow infected with any other disease.

II How would you simply and quickly check for presence or absence of mastitis infection in your milk?

1. Strip milk on back of hands to see colour changes and some foreign bodies.
2. Strip milk on white surface containers such as sufuria and check for clots.
3. Strip milk on smooth black surface or a strip cup and check for clots.
4. Strip milk on the floor to check for clots.

III Which of the following is a classical sign of a cow infected with mastitis?

1. Blood clots in milk.
2. Sudden drop in milk yield.
3. Milk clots and udder is swollen and painful to touch.
4. Animal not eating.

IV Which managerial action would you take for a cow confirmed to suffer from mastitis?

1. Isolate the cow from others.
2. Feed the cow separately.
3. Milk the cow last after the others and treat with antibiotics
4. Milk the cow before milking the others.

E. Polythene tube silage making technology

I At what stage do you ensile green maize forage to achieve optimum silage quality?

1. Before tasselling

2. At the tasselling stage.
3. When at dough or milky stage.
4. At the most leafy stage.

II Which of the following materials would you not use for polythene silage making?

1. Green maize
2 Napier grass.
3 Sweet potato vines.
4 Sorghum.

III Why would you not use the material you chose in II above for silage making?

1. It will give less silage than the others
2. It will take along time to ferment
3. Succulent stems will give poor quality silage
4. Silage will have a repulsive smell

IV When making silage, what ratio of molasses to water do you use for mixing the two before sprinkling it over the forage material?

1. 2 Kg molasses to 3 Litres of water.
2. 3 Kg of molasses to 2 litres of water.
3. 1Kg molasses to 3 litres of water.
4. 3Kg molasses to 3 litres of water.

V Why is it necessary to chop forages before ensiling?

1 To attain very good palatability of silage.
2 To enable me ensile more forage materials.
3 To aid the compaction and exclusion of air from the material.
4 To remove water completely from the forage

F. Napier grass fodder management

I What is the spacing for establishing napier grass in this area?

1. 4ft by3 ft.
2. 2ft by 2ft.
3. 3ft by 2ft.
4. 3ft by 3ft.

II Which legume can you intercrop with napier grass successfully?

1. Lucerne.

2. White clover.
3. Desmodium.
4. Calliandra.

III What planting materials do you need to establish napier grass?

1. Seeds.
2. Seedlings.
3. Splits or canes.
4. Seedlings and splits.

IV How many cows can one acre of napier grass forage support in your area?

1. One cow
2. Two cows and one heifer
3. One cow and one heifer
4. One cow and two heifers

SECTION C: Skills in Dairy Management Test Questionnaire

The following questions concern farmers` skills of various dairy management technologies. Respondents are asked to give a rating reflecting the level of skills they have attained in performing a technological aspect of a given dairy management technology.

A. A.I Technology

I How skilled are you in detecting heat in your dairy cow?

1. Low
2. Average
3. Just above average
4. Excellent

II How skilled are you in determining the right time to inseminate a cow for highest chances of conception to be realised?

1. Low
2. Average
3. Just above average
4. Excellent

III How skilled are you in managing a cow that has failed to come on heat after long time?

1. Low

2. Average
3. Just above average
4. Excellent.

IV How skilled are you in determining the optimum moment for first service of a heifer?

1. Low
2. Average
3. Just above average
4. Excellent.

B. Calf rearing technology.

I How skilled are you in managing a calf during the first week of life?

1. Low
2. Average
3. Just above average
4. Excellent.

II How skilled are you in achieving good growth rate in calves?

1. Low
2. Average
3. Just above average
4. Excellent.

III How skilled are you in detecting health problems in calves?

1. Low
2. Average
3. Just above average
4. Excellent.

IV How skilled are you in maintaining good housing for calves?

1. Low
2. Average
3. Just above average
4 Excellent.

C. **Dairy cow feeding technology.**

I How skilled are you in making a balanced ration for dairy cows?

1. Low

2. Average
3. Just above average
4. Excellent.

II How skilled are you in feeding a lactating dairy cow to her nutritional requirements?

1. Low
2. Average
3. Just above average
4. Excellent.

III How skilled are you in feeding alternative feeds to dairy meal to your cow?

1. Low
2. Average
3. Just above average
4. Excellent.

IV How skilled are you in using an interpreting feeding information given in dairy meal and mineral packages?

1. Low
2. Average
3. Just above average
4. Excellent.

D. Management of mastitis technology

I How skilled are you in preventing mastitis infection in your herd?

1. Low
2. Average
3. Just above average
4. Excellent.

II How skilled are you in detecting mastitis infection?

1. Low
2. Average
3. Just above average
4. Excellent.

III How skilled are you in using a mastitis detecting equipment?

1. Low

2. Average
3. Just above average
4. Excellent.

IV How skilled are you in managing a cow infected with mastitis?

1. Low
2. Average
3. Just above average
4. Excellent.

E. Polythene tube silage making technology

I How skilled are you in polythene tube silage making?

1. Low
2. Average
3. Just above average
4. Excellent.

II How skilled are you in determining the optimum stage to ensile a given material for high quality silage?

1. Low
2. Average
3. Just above average
4. Excellent.

III How skilled are you in ensuring proper mixing of molasses and water for good quality silage?

1. Low
2. Average
3. Just above average
4. Excellent.

IV How skilled are you in compacting forage material for silage making?

1. Low
2. Average
3. Just above average
4. Excellent.

V How skilled are you in keeping and using dairy management records?

1. Low

2. Average
3. Just above average
4 Excellent.

F. Napier grass fodder management.

I How skilled are you in napier grass fodder establishment**?**

1. Low
2. Average
3. Just above average
4. Excellent.

II How skilled are you in feeding napier grass to cows for good performance?

1. Low
2. Average
3. Just above average
4. Excellent.

III How skilled are you in intercropping napier grass with legumes?

1. Low
2. Average
3. Just above average
4. Excellent.

IV How skilled are you in choosing napier planting materials for good establishment?

1. Low
2. Average
3. Just above average
4. Excellent.

V How skilled are you in using the right forage materials for silage making?

1. Low
2. Average
3. Just above average
4. Excellent.

SECTION D: Dairy Herd Productivity Test Questionnaire

A. AI technology

1. After how many services did this cow conceive? Cow no: 0…Bull 1… 2… 3……

other(#)

2. Do you rely on somebody else to detect heat? Yes ☐ No ☐ Sometimes ☐

B. Calf Rearing

1 In a year how many calves are born in your herd?

2 How many calves die before weaning?

3 In a year how frequent are your calves infected with a disease?

C. Mastitis control

1 How many of your cows got mastitis in the last two years?

2. Have you ever had a mastitis case you did not know and was identified to you by someone else?

D. Polythene tube silage making

1 How many times have you made silage using polythene tube in your farm during the last two years?

2 How times has your silage been spoiled during the last two years?

3. Do you make silage on your own or hire expert to assist you?

E. Dairy cow feeding

1 Body condition score of the dairy cow? 1...very good 2...good 3... Fair 4… Poor 5… Very poor

F. Napier fodder management

1 Do you top-dress your napier immediately after cutting 1…Frequently 2…Sometimes 3…Never

2 How regular do you weed your napier grass? 1 Frequently 2 sometimes 3 Never

3 Have you ever experienced napier headsmut in your farm? Yes ☐ No ☐

4 If the answer to 3 above is yes, what was the management action that you took? 1 Uproot napier 2 Burn the affected napier stool 3 Did not know what to do?

APPENDIX B: STUDY PERMIT