ASSESSMENT OF DEMAND FOR DAIRY COW FEEDS AND MARKET PARTICIPATION DECISION OF SMALL-SCALE FARMERS IN KIAMBU COUNTY

BY

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A Thesis Submitted to the Graduate School in Partial Fulfillment for the Requirements of the Master of Science Degree in Agriculture Economics of Egerton University

EGERTON UNIVERSITY

May, 2017

DECLARATION AND APPROVAL

Declaration

I declare that this is my original work and it has not been presented in this or any other university for the award of a degree.

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Approval

This research thesis has been submitted to Graduate School of Egerton University with our approval as University supervisors.

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DEDICATION

I dedicate this work to my beloved husband, son and my mother. “For you gave it all so that I could get it all”.

God bless you.

ACKNOWLEDGEMENT

Above all I thank the almighty God for giving me the energy and good health during the entire period. I wish to acknowledge Egerton University and the entire staff of the Department of Agricultural Economics and Agribusiness Management, under the leadership of Prof. George Owuor for their sincere and honest support since I enrolled for the studies. Special thanks go to my University supervisor Prof. P. Mshenga and Prof. B. Njehia for their tireless and invaluable effort in guiding and supporting me during the entire study and research period. Secondly, I wish to acknowledge. My appreciations go to the Ministry of Agriculture, Livestock and Fisheries (MoAL&F), for allowing me time to do the study and provide valuable secondary data most of which was used in the analysis. Thanks to Githunguri dairies personnel who supported and facilitated me during data collection and availed all necessary information for this study. Gratitude goes to my family for their financial support and prayers. The contribution by many other individuals and the positive criticisms from my colleagues and friends during the period of my studies will not go unmentioned. All glory and honor are unto His holy name.

ABSTRACT

In recent times, dairy farming has become a major economic activity for many smallholder farmers in Kiambu County. This has been encouraged by the rising demand for milk and dairy products by the growing population. Following this, there has been an increased demand for dairy cow feeds by the small-scale farmers and therefore the need to do this study. The general objective of the study was to contribute to improved livelihood by determining level of demand of dairy cows feed and promote farmers' market participation decision making. This study utilized both secondary and primary data sources with the questionnaire being adopted as the major data collection tool. A Multi-stage sampling method was used to come up with a sample of 150 dairy farmers that were interviewed. To analyze the data, the study utilized descriptive statistics to determine small scale farmers' characteristics. Almost Ideal Demand System (AIDS) model was applied to assess demand for dairy cow feeds. The double hurdle model was used to analyze the decision to participate in the market and extent of participation. The results from the study indicated that 90% of the farmers participated in markets for cows' feeds in the study area. On the demand for cows feeds, the Hicksian result indicated that value of compensated own price elasticity for by-products was found to be the lowest (-0.31), followed by that for minerals (-0.28), then concentrates (-0.19) and highest was fodder at (-0.16). The Uncompensated/ Marshallian own price elasticities in absolute terms was found to be lowest for minerals (-0.36) followed by by-products (-0.37) then Fodders (-0.46), and finally concentrates (-0.69). The calculated expenditure elasticities for all the cow feeds were found to be positive and less than one, indicating that they can be considered normal/ necessary goods. Gender, education and age were found to influence the decision to participate in markets for cows' feeds. On the other hand age, extension service, farm size, on-farm incomes from milk sales and crops had an influence on the extent of farmer's participation in markets. Information generated will be utilized by small scale farmers, dairy co-operatives and all stakeholders. This study will be useful to the target population to understand the various strategies of feed conservation aiming at sustaining stable milk production. Policy implications include proper planning of feed supplies, creation of opportunities and reduction in cow feeds prices. Policy makers to identify points of interventions and as such design effective and efficient mechanisms on promotion of irrigation schemes and water harvesting technologies to create a seamless availability of cow feeds.

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LIST OF ACRONYMS

AEZ	Agro Ecological Zones
AI	Artificial Insemination
AIDS	Almost Ideal Demand Systems
ASAL	Arid and Semi-Arid Lands
CLS	Common Livestock Systems
CP	Crude Protein
DMI	Dry Matter Intake
GDP	Gross Domestic Product
GOK	Government of Kenya
FAO	Food and Agriculture Organization
KARI	Kenya Agricultural Research Institute
KCC	Kenya Cooperative Creameries
KNBS	Kenya National Bureau of Statistics
LA	Linear approximation
LEWS	Livestock Early Warning Systems
LU	Livestock Unit
LWT	Livestock Weight
MDGs	Millennium Development Goals
MOA	Ministry of Agriculture
MOLD	Ministry of Livestock Development
R&D	Research and Development
TLU	Total Livestock Unit
SHS	Single Household Survey

CHAPTER ONE
INTRODUCTION

1.1. Background Information

The agricultural sector plays a dominant role in the Kenyan economy directly accounting for approximately 26% and indirectly 25% of Gross Domestic Product (GDP), (GOK 2010). Major agricultural activities in Kenya are crop production, horticulture as well as dairy and other livestock farming. Traditionally, foreign exchange earners have been tea, coffee, and horticulture. Others are fruits, vegetables, cut flowers, beef and dairy products.

The livestock subsector accounts for approximately 10% of national GDP. This is 30% of the agriculture GDP (National livestock Policy, 2008). It employs 50% of the national agriculture work force and about 90% of the Arid and Semi-Arid Lands (ASALs) work force (Behnke and Muthami, 2010). The National census of 2009 established Kenya's animal resource base to be 17.5 million cattle, 27.7 million goats, 17 million sheep, 3 million camels, 31.8 million domestic birds, 1.8 million donkeys and an undetermined number of companion, game and aquatic animals. Animal resources provide livelihoods and wealth for Kenyans and significantly contribute to the national economy (GOK, 2015). The main products include white meat from pigs and poultry, red meat from cattle, goats, camels and dairy culls, milk, wool, skins, hides, and eggs. The subsector's importance has increased in recent times due to increasing demand for foods of animal origin.

The increased demand for foods of animal origin is as a result of population growth, urbanization and increasing incomes, concomitant with a diet shift towards animal products. The massive increase in demand for meat products over the past few decades has created significant opportunities for smallholder farmers to meet this demand from their farm produce as well as improved household income and welfare (Herrero *et al*., 2010). However the production potential of grazing lands has declined, but the extent of the decline has been poorly quantified and has not been documented. Additionally, in Africa rangelands though currently contestable, uncontrolled grazing and recurrent drought have considerably reduced their carrying capacity, (FAO, 2013). This has led to the need for improved livestock systems and or technology application as well as increased demand for fodder/grasses and subsequently a decrease in production capacity.

Dairy cattle feeds in Kenya account for between 60-80 percent of the production costs in livestock farming, depending on the intensity of production. In countries where production systems are advanced, the cost of feeds still account for more than 50% of the total production costs (GOK, 2001). This proportion means that other necessary additional inputs into the production system (labor, breeding, power, water, medication and services) contribute relatively low to the total cost of cow's feeds.

Kenya's livestock feed industry comprises of such components as the pastoral (forage pasture/ fodder), industrial by-products and manufactured feeds. The pastoral feeds provide the principal dietary component for ruminant production (cattle, goats, sheep, camels), while manufactured feeds may be used as and when necessary and are primarily applied to intensive production mainly for pigs and poultry (FAO, 2013). The industrial by-products comprise of dry yeast, brewers waste and pineapple pulps which are often used mainly for feeding the dairy cattle during periods when pasture/ forage is scarce and or when concentrates prices are high. The main ingredients for the manufactured feeds are wheat bran, wheat pollard, maize bran, maize germ and rice bran, which are often scarce in the market resulting in high prices for these feeds. The kinds of feeds used depend on the dairy system the farmer is applying.

Extensive dairy systems are exclusively fed by pastoral feeds and natural pastures such as grasses and cultivated weeds. Semi-intensive production systems such as those rearing cross breeds use fodder crops that include; kales, cabbages, sweet potato, and Napier grass as principle dietary component and feed concentrates may be added as supplement. Intensive production systems maintain mainly exotic dairy breeds in high density pens; use formulated feeds with hay, Lucerne, Napier grass, and concentrates as supplements (Radull, 2005).

According to World Bank, (2012), Kenya offers numerous investment opportunities especially in livestock feeds industry due to their supply constraints. This has been aggravated by the ever changing climatic conditions experienced over the recent years, growth in the livestock sub-sector and the diminishing land sizes brought forth by land sub-divisions due to high population growth (Staal *et al*., 2009).The availability of dairy feeds has been a major impediment to productivity due to frequent droughts, lack of appropriate technical knowledge in water harvesting, storage and irrigation, high inputs costs, lack of market information, and lack of feed

balance inventories (Thornton, 2010). Due to these supply constraints, it is important to assess where there are gaps and opportunities within the dairy cow's value chain for the public and private sectors to invest in order to curb feed shortages for the dairy cows in many parts of the country.

Small scale dairy farmers especially from Kiambu County often face unforeseen risks that hinder own sufficient production of feeds required to meet the nutritional requirements of their cows. This therefore forces the farmers to make decision to source for the deficit feeds from the markets and either participates as buyers or sellers depending on own production at different levels. This on the other hand makes feeding of dairy cattle account for the highest proportion (50-80%) of production costs depending on the level of dependence or participation of the farmer in the markets for feeds. However, proper planning and management of feeds can only be attained, if farmers access and apply knowledge on simple feeds conservation practices, water harvesting and conservation methods, and understanding the required nutritional needs of the dairy cows while reducing disease infection *ceteris paribus* thus increasing productivity.

1.2. Statement of the problem

Of major concern to all the stakeholders in the livestock subsector has been demand for dairy cow feeds. Favorable weather, good soils for growth of forage, and proper management are critical for obtaining maximum dry matter intake from grown feeds. Proper nutrition of the cows enhances good health, increased reproductive efficiency, and optimum milk production during the various lactation stages. Currently, Kiambu County does not have an integrated information data bank on dairy cattle feeds demand. This creates an information gap on the proportion of the dairy cattle feeds supply and demand needed by the current dairy cattle populations. Land constraints, unreliable weather conditions coupled with high cost of commercial feeds have further aggravated the demand for the dairy cattle feeds. These and other factors have brought in-consistencies in feeds availability thus affecting viable returns for the small scale farmers. Therefore, it is imperative to do an accurate assessment of the current dairy cow feeds demand by small-scale farmers and their participation decision in feeds market in Kiambu County. This will point way forward for the national food security policy and planning, while identifying opportunities available in dairy cow feeds marketing.

1.3. Study Objectives

1.3.1 General objective

The general objective of the study is to contribute to improved livelihoods by determining the level of demand for dairy cows feed and promoting small scale farmer market participation decision making in Kiambu County.

1.3.2 Specific objectives

i. To characterize the small scale dairy farmers in Kiambu County
ii. To identify the demand for the dairy cow feeds in Kiambu County
iii. To determine the factors influencing decision of small scale farmers to participate in the markets for dairy feeds in Kiambu County.

1.4. Research questions

i. What are the characteristics of small scale farmers in Kiambu County?
ii. What is the demand for dairy cow feeds in Kiambu County?
iii. What factors influence the decision of small-scale farmers to participate in the markets for dairy cow feeds in Kiambu County?

1.5. Justification of the study

To achieve the goals and objectives of Vision 2030, livestock feed subsector is one of the major subsectors that will enable and boost the delivery of Kenya's meat, hides and skins, milk and dairy products meet local and international marketing demands standards. Due to increasing demand for these products, cows have to be fed well in order to increase their productivity. In return the dairy cattle feed industry in Kenya can have enormous potential that could provide a source of livelihood to millions of people. However, inadequate nutrition is a major constraint that impact negatively on the growth and viability of dairy cattle farming in Kenya. To achieve sustainable development goal of halving people living in absolute poverty especially in rural areas; there is need to re-look at the dairy feeds market role and performance. Identified gaps will provide valuable information in developing opportunities for feed related investment in the dairy cows' commodity value chain strategy. This study will provide guidance to stakeholders in dairy feeds industry; farmers, government agencies and non-governmental organizations on

issues related to feeds supply. It will further facilitate in identifying possible areas of investment opportunities, by identifying points of intervention that will lead to formulation of effective and efficient enhancing policies. The decisions of the stakeholders and agents in the feeds industry are dependent on various prevailing constraints and mainly available feed resource in various Respondents, communities and markets. An understanding of dairy feeds demand and the ability to forecast priorities for potential investments will help in understanding the market as a whole. This study will analyze strategies used by small scale farmers to conserve available fodder as a lesson to target population aiming at sustaining stable milk production.

1.6. Scope and limitation of the study

The research was restricted to analysis of demand for dairy cows' feeds and characterization of small scale farmers while determining their market participation decision in Kiambu County. The study focused on four cow feeds namely *Pennisetum purpureum* (napier grass), hay, agro-industry wastes (pineapple pulp, brewers waste and yeast) and concentrates (dairy meal). The livestock species of interest to the research was the dairy cow. Feed losses from harvesting, transportation, straw used for bedding, storage and seasonality were limiting constraints, which should have been considered, however, no records were available and time was a limiting factor. This study required weighing, and recording types of feed fed daily to cows using different measuring scales by farmers which were not conducted due to time and resource constraint.

1.7. Definition of terms

Adlibitum: Continuous access to feed/s that permits livestock to satisfy their appetite for that available feed/s (WT). Diet offered free-choice, allowing animals to eat as much as they desire; typically allows for 10% leftover from a daily allotment.

Agro-industrial by-products: Feeds produced during the industrial processing of plants and their seeds, for example brewing and distillery residues from grains and molasses from sugarcane. This study will focus on wet yeast, pineapple pulp and brewers waste.

Balanced ration: The daily food intakes that provide all required nutrients in proper proportion for normal health, maintenance (of body weight), growth, reproduction, lactation or work.

Bran: Coarse outer grain coating, separated during processing.

Concentrates: Classification of feedstuffs high in energy and low in fiber, usually further

divided into energy and protein concentrates. Often used interchangeably with supplement (for example corn, barley, soybean).

Feed: Materials of nutritional value fed to livestock. Each species has a normal diet composed of feeds or feedstuffs which are appropriate to its' kind of alimentary tract and which are economically sensible as well as being nutritious and palatable.

Feed Assessment: is a data and computation-based analysis of the supplies and demands for livestock feeds in a country, where livestock includes all beef and dairy cattle, sheep, goats, buffalo, swine, equines and poultry (FAO, 2012).

Fodder: Green or cured plants such as maize and sorghum, browse as small stems, leaves, flowers and fruits of shrubs, trees or woody vines.

Hay: Grasses and forage legumes that have been cut and dried for livestock feed (WT)

Market: The set of actual and potential buyers of a special product, (Kotler, 1997). In this study, a market is conceptualized as any structure that allows buyers and sellers to exchange any type of goods, services and information.

Market participation: Take part in the buying and sale of goods and services

Off farm incomes: Is generated when a farmer, spouse or other family member works off the farm, thereby generating extra income for the family.

Straw: The dry remains of a cereal crop (for example. rice or wheat) after the ears are removed/ harvested

Supplement: Feed or feed mixtures used to improve the nutritional value of basal feeds. A supplement is rich in one or more of protein, energy, vitamins, minerals or antibiotics, and is combined with other feeds to produce a more complete feed. Often used interchangeably with concentrate.

Ration: Fixed allowance of total feed for an animal for one day. Usually specifies the individual ingredients and their amounts and the amounts of the specific nutriments such as carbohydrate, fiber, individual minerals and vitamins.

Zero grazing/ Stall-feeding: A management system in which all feed is taken to livestock that are confined to a stall or pen.

CHAPTER TWO
LITERATURE REVIEW

2.1 Livestock Sector Overview

The livestock sector contributes about 40 percent of agricultural GDP and provides livelihood for about one billion people globally according to (World Bank, 2012). The livestock subsector in Kenya accounts for approximately 10% of national Gross Domestic Product (GDP), which is 30% of the agriculture GDP, (National livestock Policy, 2008). In Kenya, the key livestock subsectors are beef, dairy, sheep, goats, camel, poultry, piggery, bee keeping and emerging livestock. The livestock products often fall short of demand and with projected rapid economic growth and population increase, accompanied with an increase in per capita income, it is anticipated that more people will tend to consume more animal proteins (Thornton, 2010). To increase livestock productivity that will enable meet this demand; provision of animal health, livestock breeding services, extension services and animal feeds both in quantity and quality should be strengthened (GOK, 2005).

Dairy feeds are an important input in the application of improved techniques of production for high yielding dairy cows. With regard to commercial livestock production especially high quality stock for example grade dairy cows, commercial poultry and pig production; feed concentrates determine level of profitability of the enterprise (GOK, 2001). As a result, the livestock feeds subsector is significant and a major determinant of the success of livestock industry in Kenya and around the world. The importance of feeds in the livestock subsector is due to the fact that feeds account for between 60-80 percent of the production costs in livestock farming, depending on the intensity of production (GOK, 2001). Furthermore, where production systems are advanced, the cost of feeds still account for more than 50% of the total production costs, and has the most impact on animal health, production and reproduction. Proper livestock feeding is the key determinant of the enterprise profitability (NAFIS, 2010).

2.2 The Dairy feeds industry subsector in Kenya

Kenya livestock feed industry comprises three main components, the pastoral (forage pasture/ fodder), industrial by-products and manufactured feeds. Forage pastures account for 70% of nutrition component that an animal requires for production and maintenance. Various sources of

forage pastures in Kenya include natural pastures containing grasses known to be of high nutritional value (Strange, 1963), such as star and Kikuyu grasses. Currently these grasses are being replaced by fodders such as napier grass, not only due to their low yield potential but also desire by farmers to adopt the new technology of zero grazing. Other fodders include sweet potato vines, giant Setaria, sorghum and brassicas, however, literature on their demands and supply are currently limited (Potter, 1983).

Industrial by-products such as wet yeast, pineapple pulp, brewers waste and spent grain are materials that are increasingly being adopted as an improved affordable feeding technology. This occurs at a time when most smallholder dairy farmers are grappling with an increasing cost of conventional feeds like dairy meal whose prices have been erratic partly due to unstable economic conditions in a country that is predominantly dependent on imports of grains. The alternative to the industrial by-products are dairy meal, maize germ, wheat germ and pollard however these are highly prized. The by-products can be fed to cows alone although majority of small-scale farmers prefer complementing it with pastures like hay, napier or crop residues at different ratios. Apart from increasing the milk output from the cows, spent grain also enhances fattening in bulls therefore being ideal to any farmer with cattle. This supplement can mitigate the problem of inadequate feeding in all systems due to shortage of quality and quantity of forage and fodder particularly during the dry season, (Omondi, 2013).

Bran, maize germ, pollard, dairy meal, wheat germ, oats and rice grains have all been considered as concentrates made by manufacturers. The exact role of commercial concentrates on the smallholding depends largely on the relationship between milk price and the cost of concentrate. Due to a shortage of grain, by-products and oil cakes, price of animal feed has on average increased by 50-94 percent (Akefema, 2011). Kailikia, (1992), further indicated that the animal feeds industry was characterized by a high degree of concentration and inequality, with one firm, Unga Feeds Limited controlling over 75 percent of the market share. During the dry periods, it has become very common to see piles of grass, hay or other roughages for sale by the side of the road around Nairobi, and at many places in Kiambu County. Livestock owners have had little option but to pay the price asked as the supply of feed on their own holdings is often low. The extent at which the purchase of this forage is being supported by the returns smallholders are able to obtain by selling milk direct to the consumer or co-operatives requires investigation

(Githunguri Dairies, 2011). At the producer level, solutions may include aspects of choosing and accessing the best feeds from those locally available and, as feeds market expands, from new sources (Herrero *et al*., 2010; McDermott *et al*., 2010; Tarawali *et al*., 2011).

2.3 Dairy cow feeds supply and demand

According to FAO, (1983) livestock feeds provide the basic nutrients required for animal production, including energy, proteins amino acids (macro-nutrients), minerals, vitamins and other micro-nutrients. Feeds may be broadly classified as concentrates and roughages, depending on their composition. Concentrates contain a high density of nutrients, usually low in crude fiber content (less than 18% of dry matter (DM)) and high in total digestible nutrients. Roughages, including most fresh and dried forages and fodders have a low density of nutrients, with crude fiber content over 18% of DM.

According to Kailikia, (1992), Kenyan livestock feed industry is comprised of two principle components: the pastoral (forage pasture/fodder) and manufactured feeds. The pastoral feeds provide the principle dietary component for ruminant production (cattle, goats, sheep, and camels). On the other hand manufactured feeds may be used mainly in intensive pig, poultry or dairy production. A recent life-cycle analysis for the dairy sector showed a huge potential for moderate efficiency gains in developing countries (FAO, 2010c). On the contrary, well-adapted, hardy breeds were said to be advantageous in utilizing the vast areas which were under rangelands (FAO, 2006b).

Singh *et al*. (2012) found out that fodder was the critical input in livestock development. His findings showed that there existed a huge gap between demand and supply of fodder (both dry as well as green). In order to promote fodder production and requirement some Governments have found it imperative to come forward and develop fodder storage facilities at different locations in different regions, so that farmers can store fodder to ensure its availability throughout the year. Due to lack of adequate storage facilities and space, producers have been forced to dispose the fodder in excess of their storable surplus and therefore many times marketed surplus exceeded the actual stored surplus in this way.

According to a report by KIPPRA, (2012), challenges facing the dairy sector in central Kenya include poor access to quality feeds. This is due to high cost, unavailability of fodder during dry periods and low quality fodder. Support to this part of the chain would entail popularizing high value forage crops, enhancing fodder preservation for the dry seasons, investments in storage facilities for natural fodder and promotion of home feed rationing to reduce feed costs. Other measures should include establishment of cottage feed mixers by farmers and youth entrepreneurs and establishment of small feed mills by co-operatives and farmer groups. While local production of vitamins, amino acids, macro and micro-nutrients for the feed mills can also be undertaken by large scale investors.

While forage is the principle livestock feed in Kenya especially dairy cows, its quality and quantity vary both spatially and temporally (Randull, 2005). The climatic conditions during the rainy season produce high quality fodders that with the onset of the dry season, become lignified and are thus of lower nutritive value. By preserving silages during the rainy season, farmers compensate for the reduction in the nutritional quality of fodder during the dry season. Currently, farmers preferentially plant Lucerne, Desmodium, Leucaena, Dolicho lab lab among others. Crops residues include kale, cabbage, carrot, sweet potato and vines. In addition to farmers' individual participation, the Kenyan Government has initiated programmes to increase the country's annual fodder harvest through extension programs and provision of free training manuals. Unfortunately, unpredictable rainfall patterns have hampered these programmes, and in some cases they have met with little success. In addition, there is lack of both skills and equipment that could be used to improve processing and preservation techniques. As a result, the quantity and quality of fodders have not improved significantly over the past decade.

Stewart, (2006) revealed that the popularity of calliandra had spread in Kenya from Embu to other parts of central Kenya. It was also starting to be used for fodder to a significant degree in other parts of the region, including the Lake Victoria Basin (western Kenya and southern Uganda) and the area around Mt. Kilimanjaro in northern Tanzania. However, the number of smallholder dairy farmers using the technology was still a small fraction of those who could potentially benefit. Fodder shrubs have the potential to have a substantial impact on the livelihoods of smallholder dairy farmers in the tropics, particularly in high potential sub-humid areas where land holdings are too small for extensive grazing systems.

Without fodder shrubs, the only feed available on the farm during the dry season is dry grass and crop residues such as sweet potato vines and maize or sorghum stover, most of which are of poor quality. Some farmers alleviate this problem by buying dairy concentrate (dairy meal), but this is of variable quantity which often do not meet requirements of the cows because they are too expensive to be used by the poorer farmers. By growing their own high-protein fodder shrubs on the farm, instead of buying dairy meal, farmers can save money, while those who could not previously afford supplements can achieve substantial increases in milk production for higher income and/or family consumption.

2.4 Preference and demand for dairy cow feeds

There are many factors that farmers consider before making decisions on what to feed their dairy cattle. A study by Lusk and Natalie, (2009) indicated that consumers preferred feeding cows with grass fed diet as opposed to supplementing with fishmeal and flaxseed to improve the fatty acid content in feed because the latter proved to be expensive. While analyzing management and feeding systems in Ethiopia, Tesfaye and Chairatanayuth (2007) revealed that crop residues were fed either alone or in combination and without much attention to improve their feeding values, either through supplementation or any form of processing. In both studies, availability of feed, cost implication and lack of information on nutritional content of various feeds determined the choice of feeding regimes adopted by the farmers.

In a study determining the derived demand for cattle feeding inputs in Texas, Mathew *et al.* (2008) used Mcfadden dual cost function. They revealed that there was a systematic difference in feed demand relationships among different weight categories. It was also noted that negative cross-price elasticities between weight categories provided evidence for an alternative objective function associated with longer term feeding of lightweight feeder cattle. The study further demonstrated seasonality differences across weight categories. A study by Hansen (2012), using simulation model revealed that with an increased consumption of livestock products in Vietnam and Thailand, there was a subsequent increase in quality feed demands. The study also noted that as emerging market economies grow and food consumption patterns changed there would be an increase in pressure on global feed for livestock production.

Changwony and Kitilit (2007) assessed feed types, quantity fed and their effects on milk density in Kenya. They noted that farmers grow Napier grass and Boma Rhodes pastures and use them as livestock feed supplements. In addition, legume forage included Lucerne, Calliandra, Desmodium and sweet potato vines. Moreover, it was shown that majority of the farmers provided feed supplements to lactating cattle, which included homemade and commercial concentrates as well as mineral lick. However, the study also revealed that most of the farmers fed their cattle in such a way that it did not promote both high milk yield and density. Forage production and quantities fed was found to be sub-optimal for cattle to express their genetic potential for milk yield.

According to Avazov (2013), constraints to grazing and knowledge of appropriate lopping regimes for different fodder species influenced the decisions on feed demand and use by farmers. Moreover, access to off-farm fodder sources and the numbers of livestock kept affected fodder management by Respondents. The study further revealed that exchange of local knowledge regarding local fodder management and labor use on fodder collection resulted in improvement in the levels of fodder supply.

2.5 The Price effect of inputs on dairy cow feeds

Feeds markets play a vital role in dairy cattle development. In addition, restructuring farms and productivity gains are based on a greater reliance on purchase of livestock feeds. As such, high reliance on purchased feeds may lead to decreased number of dairy cattle due to high cost in feeding them. An analysis of the dynamic adjustment of demand for distiller grain as feed and livestock markets revealed that corn demand was inelastic which suggested that livestock producers faced high feed cost in response to high corn prices (Suh and Moss, 2014).

Roberts *et al.* (2008), using recursive model in determining factors affecting hay demand and supply in Tennessee, found out that hay market analysis indicated that yield and acreage were price inelastic and inflexible with respect to the quantity produced. Further, they revealed that hay price was responsive to real per capita income mainly because an increase in per capita income resulted in more purchasing power for a household transitively leading to increased consumption level.

O'Brien (2009), in a study of the effects on micro-market structure have on spatial grain price differentials revealed that corn and wheat prices were affected by local supply-demand, business organization, livestock feed usage, storage capacity, market structure and transportation access. They further found out that, presence of operating costs and efficiency differences indicated the presence of market power in the local markets.

Marsh (2007) in a study on cross-sector relationships between corn feed grains, cattle and poultry economies showed that there is unequal cross-effects on market disturbances for example market shocks in cattle and poultry have more impact on corn demand and supply than shocks from corn on cattle and poultry markets. The study concluded that livestock numbers directly affects demand of corn.

Arethun and Bhatta (2012) on their study in Ethiopia found out that reduced price of manufactured goods and increased farm gate price of agricultural goods was as a result of farmers' access to rural roads. Both participation in markets and the amount of purchased inputs for example dairy feeds use were significantly different for Respondents with respect to the degree of road accessibility.

2.6 Dairy cow feeds access and constraints

New institutional arrangements including appropriate regulatory policies and technologies are required in order to ensure cow feed is accessible while addressing the various constraints. A study by Thairu and Tessema (1987) showed that the problem of continuity of feed supply should be addressed by designing an integrated feeding system that includes improvement of natural pastures, production of pasture grasses and fodder crops. Furthermore, they added that an increased use of crop residues in combination with legume fodders such as Leucaena should be used to ensure adequate nutrition to livestock. According to findings by Abate *et al*. (1984) limited amount of land under grazing in high potential areas coupled with a bias towards cash and food-crop production. This led to development of intensive systems of livestock production which include semi-zero grazing or cut and carry system/ zero-grazing units.

Porter (1984) indicated that decreasing land sizes would undoubtedly place more strain on the livestock feeding system. Land subdivision was likely to continue reducing effective farm size.

Increase in stock numbers per holding as a strategy to increase farm milk output was clearly not likely to be effective. This was because forage resources were already limiting milk production for the existing animals and the proportion of feed required for maintenance rather than production would increase.

Availability of livestock feeds especially during the dry season has shown to result in low milk yields as well as declined growth rates of the dairy cows in the farm. Studies carried out in Kiambu district indicated that two major constraints lowering milk production in smallholder dairy production systems were limited availability of feed (Omore *et al.,* 1994) and poor reproductive management (Odima *et al.,* 1994). A study by Emongor *et al.,* (1999) concurred with the findings of Omore *et al*., (1994) meaning that availability of cattle feed limits milk production on smallholder farms. In Kenya small scale farmers are constrained in accessing cow feeds by various issues which include high feed prices, lack of clear guidelines to restrain poor quality feeds from the manufacturers reaching the retail shops, lack of technical knowhow on feed formulation for home rations and unreliable weather patterns. A study by Le Thi *et al.,* (2013) indicated that among the major constraints to livestock production and marketing, perceived by farmers, was the high and rapid increase in feed price and the insufficiency of market information and weak bargaining power. To enhance livestock production and marketing by farmers, the government's role in facilitating the domestic supply of feeds and raw materials should be strengthened to create a stable feed price.

2.7 Investment opportunities in the dairy cow feeds industry

According to World Bank (2012), on strategic ways to improve the availability and utilization of feed, there are three ways through which feed related development, research and related investments can effectively support more livestock production and increase the market orientation of smallholder Respondents. The three strategic areas for improving the availability and/or the utilization of feed by resource-poor Respondents are; to produce more feed from the household's own resources; import feed from common property resources or, more likely, through feed purchases from the market; and, utilize better the feed available to the household.
According to Blümmel (2010b), in the context of the hundreds of millions of resource-poor livestock keepers in crop-livestock systems, a household might be supported to produce more

(quantity and quality) feed from own land. This would be by replacing their traditional staple crop varieties (grain, roots or tubers) with varieties that yield more total biomass with better feed quality (human food and livestock feed). Or there may be the opportunity for the household to replace some of its natural pasture with a higher-yielding grass (although fertilizer application may be required) or mix with other herbaceous or woody forage species (Reynolds *et al*, 2005). Alternatively, buying agro-industrial by-products ("concentrates/supplements") from the local mills may be one of the other ways of importing more feed, although one that would require the household having cash -or access to credit- and prioritizing the use of the cash for purchasing feed. Farmer co-operatives or associations may also facilitate such access. Feed transport is becoming increasingly important in intensifying crop-livestock systems, and strategies that enable feed densification may be important in this respect (Anandan *et al*., 2010).

Blümmel *et al.* (2009a) noted that, a household can utilize better the feed from various sources by, one way, to manipulate the physical structure of feeds (to increase intake), for example, by making feed blocks or by chopping poor quality crop residues to increase their intake). Another might be combining the feeds produced by the household or acquired from neighbors, from common property resources or from formal market channels so that the mixture of available feeds better matches the animal's nutrient requirements, thereby increasing the efficiency of conversion of the feeds to live-weight gain or milk, whether on an annual basis or seasonally. Opportunities may include interventions that are technically-based (for example. balancing rations) or that relate to market issues (for example. trading of crop residues and establishing business development services) or that require policy and governance changes (for example. business environment and feed quality regulation).

Nyangaga *et al*. (2009) in a study in Mandera, revealed how investment opportunities have emerged through sale of cow feeds. The share-croppers produce most of the fodder, who after the original landowners take their share sell the surplus feeds to livestock keepers. Some of landowners lease idle plots or fallow land to roaming livestock keepers to graze on the crop residues. The other group of fodder producers is the casual laborers who have been allowed to carry weeds collected from the farm they work in, which are the weed bundles found in the fodder markets. These mixed grass-weed bundles are cheaper than the fresh maize stover and cow pea bundles. Other fodder producers include those farmers with large parcels of land who

grow napier grass utilize some for their livestock and the rest is sold to other farmers. Independent donkey cart transporters in Mandera collect money for fodder sales from the traders and deduct their fees before handing over the day's collection to the agro-pastoralist farmer (Nyangaga, 2009).

According to Kotler (1997) in urban centres, retailers often buy from wholesaler-distributors or brokers and resell to domestic consumers (farmers). In addition, animal feeds retailers have a fixed base: and are found in markets centres, stall, a shop or a place located in farms /residential areas. Among the livestock feed market actors are, fodder transporters who transport fodder from the farms to the urban markets who are usually commissioned by fodder producers for the deliveries to the market. By-products and manufactured feed transporters use trucks, pick-ups and Lorries to move cow feeds from far distances to local markets. Bicycles and motor bikes owners also act as transporters of bales of hay, stacks of napier grass, and sacks of *machicha*, pineapple pulp and 20-30 liters jerry cans of wet yeast.

The feeds manufactures are mainly industries that reconstitute various ingredients like grains, minerals, macro and micro-nutrients to come up with concentrate feeds. They sell them under various brands to cater for growth, productivity requirements at different ages of the various livestock categories. The sector is vulnerable to malpractices and often leads to low quality feeds in the markets. The concept of dairy co-operatives supplying cow feeds to farmers is gaining momentum to entice farmers to supply milk to them; a good example is Githunguri dairies. This is whereby monthly supplies of fodder, concentrates, mineral salts, hay including household consumables are supplied to farmers as debt and later deducted from their dues derived from milk sales at the end each month.

2.8 Theoretical framework

The demand theory model was utilized in this study. This was based on the linear approximation of the Almost Ideal Demand Systems (AIDS). The consumer demand theory is derived from maximization of utility over quantities of goods consumed subject to an income constraint and a vector of market prices. Deaton and Muellbauer (1980), proposed the model, which takes all commodities and treats them as a singular system. The model is flexible in conducting demand

analysis (Trimidas, 2000). The demand system expresses the dependent variable as budget shares as follows;

$$S_i = \alpha_i + \sum_j^n \gamma_{ij} lnP_j + \beta_i ln\left(\frac{X}{P}\right) + \mu_i i = 1\ ton \dots\dots\dots\dots\dots\dots\dots (1)$$

Where, S_i is the budget share of feeds i; P_j is the price of good j; X is the total expenditure of the goods in question (livestock feeds), μ_i is the random disturbance term assumed to have a mean of zero and normally distributed and P is the translog price index defined by;

$$lnP = \alpha_O + \sum \alpha_j\ lnP_j + \sum_i^n \sum_j^n \gamma_i l\ nP_i lnP_j \dots\dots\dots\dots\dots\dots\dots (2)$$

In order to make the specification of the demand system linear, while avoiding the inconsistency of livestock feed price index, corrected price index is applied as proposed by Moschini (1995) specified as;

$$lnP = \sum_{i=1}^n S_i \ln\left(\frac{P_j}{P_i}\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

The price index above is transformed into log-linear Laspeyres price index which transforms the AIDS model into the linear AIDS. To capture the effects of demographic variables on the demand patterns, while maintaining the linearity of the system, the intercept of equation 3 is modified by the translating method as;

$$\alpha_i = P_{io} + K = \sum_{k=1}^S P_{ik} d_k i\ = 1\ ton \dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Finally, the model below is a linear approximation to the AIDS model;

$$S_i = P_{io} + \sum_{k=1}^S P_{ik} d_k + \sum_{j-1}^n \gamma_{ij} lnP_j + \beta_i ln\left(\frac{X}{P*}\right) + \mu_i\ = \dots\dots (5)$$

Where; P^* is the corrected feed price, d_k and S_i is the budget share, P_{io} and P_{ik} are parameters to be estimated and μ_i is the error term. X represents total expenditure on the system of

commodities (cow feeds), Y_i is the quantity demanded for the *i*th commodity. P_i is the price index.

2.9 Conceptual framework

For an effective dairy cow feed demand assessment, the determination of the supply of feed is influenced by various factors. Among them are, whether the farmer produces feeds from own resources, or s/he buys from the market, the physical factors (land size, distance to markets, infrastructure), social factors (group membership, religion, culture) and institutional factors like price of feed, extension services access and credit access. Demand for feed is assumed to be influenced by the supply and vice versa. Likewise demand is also influenced by the quantities of feed smallholder farmers acquire from own production, and the quantities availed in the markets and vice versa. Market participation decision of smallholder farmers can either be influenced by the supply of feeds which determines feed prices due to either surplus/deficit in the markets, or by the demand for feeds by the farmers and vice versa. Type of feed required by farmers for example concentrates may force farmers to participate in markets since they do not produce this. Brokers in a market may influence farmers' decision to participate because they often tend to offer information on prices, type and or alternative feeds available. Other opportunities for trade may be created by the extent by which farmers participate in feeds market and thus enhance dairy cattle productivity towards increased incomes and poverty reduction for the small scale farmers. Figure 1 shows the representation of the factors that can influence a farmer's decision to participate in feeds market in the study area.

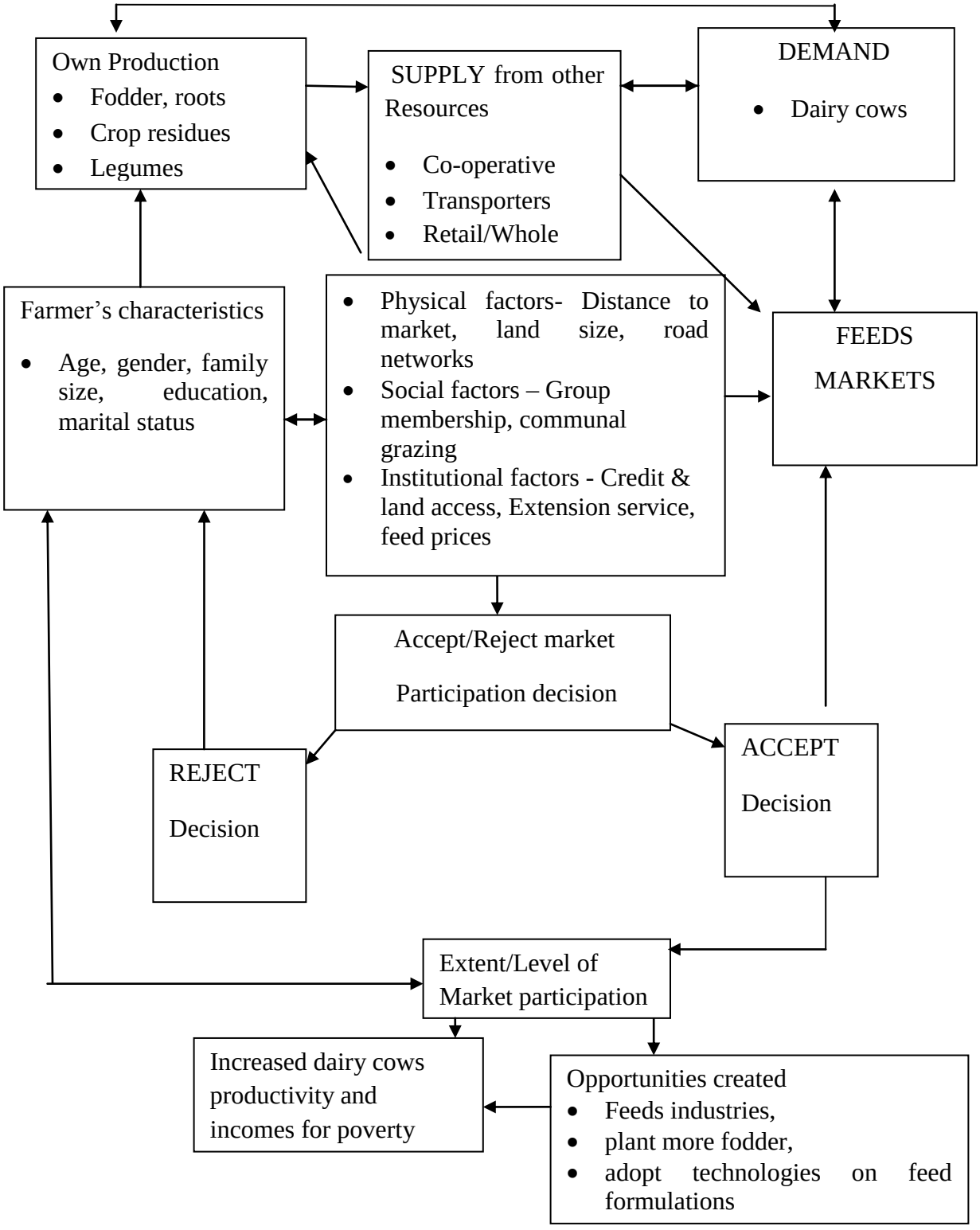

Figure 1: Conceptual framework

CHAPTER THREE
METHODOLOGY

3.1 Study area

The study was conducted in Kiambu County, Kenya. The County borders Murang'a County to the North and North East, Machakos County to the East, Nairobi and Kajiado Counties to the South, Nakuru County to the west and Nyandarua County to the North West. It covers an area of 2,543 square kilometers and constitutes twelve constituencies (Gatundu South, Gatundu North, Juja, Githunguri, Kiambaa, Kabete, Limuru, Ruiru, Kiambu, Kikuyu, Thika town and Lari). The county has eleven administrative areas namely; Lari, Limuru, Githunguri, Kiambaa (Kiambu East), Kiambu West, Kikuyu, Thika East, Thika West, Ruiru, Gatanga and Gatundu. The County enjoys favorable weather with an average temperature of 18.7^0C and an average rainfall of 989mm per annum. The main agricultural activities include dairy, poultry production, tea, coffee, pineapple production and horticulture. However some of the enterprises have declined over the years due to real estate developments which have taken over some of the coffee and tea plantations and land fragmentation due to population growth. Over the years Kiambu County dairy production has developed with majority of the farmers embracing zero grazing system. In addition some of the biggest dairy co-operatives operate within namely; Githunguri dairies, Palm dairies, Ndumberi, Brookside, KCC and other small dairies being managed by individual farmers. According to KNBS (2009), the population of cattle in the County stood at 284, 216, sheep were 147,810, and 115,903 goats. The map of the study area is as shown in Figure 2 below.

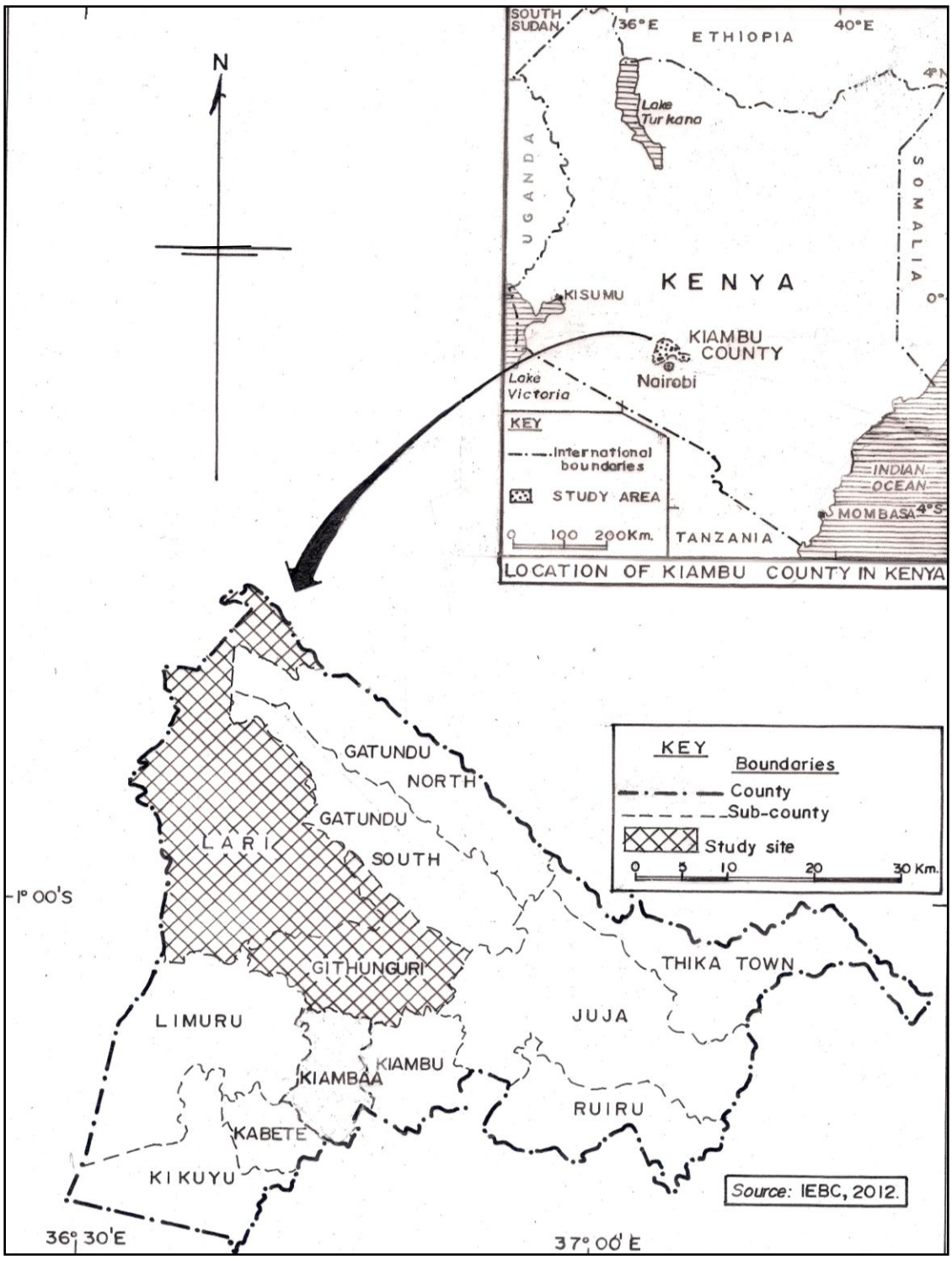

Figure 2: Map of Kiambu County.

Source: Egerton University, department of Geography.

3.2 Sampling design and sample size

The target population of the study was smallholder dairy farmers in Kiambu County. A Multi-stage sampling procedure was used in selecting a representative sample. The first stage involved a pre-selection of Kiambu County because of high concentration of dairy farmers due to being home to many dairy co-operatives and its proximity to the urban city, Nairobi. The second stage involved a purposive selection of the two among five Constituencies namely; Githunguri and Lari because the two have 57,008 and 34,890 number of cattle respectively (KNBS, 2009), which constitute 32.3% of the total cattle population in Kiambu County and both share a boundary. A systematic random sampling of 150 respondents from the Githunguri and Lari was selected on a ratio of (62:38) i.e. 92 and 58 respondents respectively based on the number of cattle each holds. According to Anderson (2004), for an unknown population, sample size was derived using the formula;

$$n = \frac{Z^{2} P_q}{e^2} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (6)$$

Where; n = Sample size; Z= confidence level (α=0.05); p = proportion of the population containing the major interest q = 1-p E= allowable error. Since the proportion of the population was not known, p= 0.5, q= 1-0.5=0.5, Z= 1.96 and E = 0.08. This resulted to a sample of approximately 150 respondents.

3.3 Sources and Type of Data

Primary data was collected by administering semi-structured questionnaires to smallholder dairy farmers. This was done to collect data on-farm characteristics, dairy cattle feed use and household feed production. Secondary data was collected from relevant publications, journals and papers from the Ministry of Agriculture, Livestock development and fisheries. Both data sets were used to determine demand of dairy cattle feeds and small-scale farmers' participation decision in feeds market in Kiambu County.

3.3.1 Analytical Methods

Primary data collected was analyzed using statistical package for social scientists (SPSS) and STATA computer softwares.

Objective 1: Characteristics of small scale dairy farmers in Kiambu County**.** This was analyzed using descriptive statistics and results presented in frequencies, means, pie charts and tables.

Objective 2: Assessment of demand for Dairy cows feed in Kiambu County

The second objective aimed at assessing the dairy cow feed demand by farmers; the demand model based on the linear approximation of the Almost Ideal Demand Systems (AIDS) was used. Consumer demand theory is derived from maximization of utility over quantities of goods consumed subject to an income constraint and a vector of market prices. Deaton and Muellbauer (1980), propose the model, which takes all commodities and treats them as a singular system, while Trimidas, (2000) argued that, the model is flexible in conducting demand analysis. Therefore, following the work of Trimidas, (2000), this study employed the linear approximation to the AIDS model;

$$S_i = P_{io} + \sum_{k=1}^{S} P_{ik} d_k + \sum_{j-1}^{n} \gamma_{ij} lnP_j + \beta_i ln\left(\frac{X}{P\,*}\right) + \mu_i \;= \dots\dots (7)$$

Where; P^* is the corrected price for feeds, d_k and S_i is the budget share, P_{io} and P_{ik} are parameters to be estimated and μ_i is the error term. *X* represents total expenditure on the system of commodities (cow feeds), *Yi* is the quantity demanded for the *i*th commodity. *Pi* is the price index. The AIDS model implies that the Marshallian price and expenditure elasticities for good *i* with respect to good *j* are given by the equations below;

$$\boldsymbol{\varepsilon_{ij=}^{M}}{}_{-\,\delta} + \left[\frac{Yi}{Si}\right] - \left[\frac{\beta i}{Si}\right] \boldsymbol{Si}$$

$$\boldsymbol{\eta_i = 1 +} \left[\frac{\beta i}{Si}\right] \qquad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \textbf{(8)}$$

Where δ is the Kronecker delta

The Hicksian elasticities can be obtained through the Slutsky equation below**,**

$\boldsymbol{\varepsilon_{ij=}^{H} \varepsilon_{ij}^{M} + \eta_{,} \mathbf{Sj}}$, as:

$$\varepsilon_{ij=}^{H} \delta + \left[\frac{\beta i}{Si}\right] - S_j \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(9)}$$

3.3.2 The empirical model specification for the AIDS is shown below;

$S_i = \beta_0 + \beta_1(Hage) + \beta_2(Hhsize) + \beta_3(Edu)_i + \beta_4(Hgder) + \beta_5(Mktdist) + \beta_6(Extserv) + \beta_7(Cowned) + \beta_8(TypCow) + \beta_9(Grpmbr) + \beta_{10}(Haypr) + \beta_{11}(ExpH) + \beta_{12}(Dmpr) + \beta_{13}(ExpDm) + \beta_{14}(Byppr) + \beta_{15}(Expbyprdt) + \beta_{16}(Minpr) + \beta_{17}(ExpMin) + \beta_{18}(Texpfds) + \varepsilon_i$

Table 1: Description of variables used in the Almost Ideal Demand Systems Model

Variables Code		Description	Measurements	Expected sign
Dependent variable				
S_i		Budget share of the jth Cow feed category		
Independent Variables				
Age	Hage	Continous	Years	+/-
Household size	Hsize	Continous	Number	+/-
Education	Hedu	Continous	Number	- /+
Gender	Hgedr	Dummy	Female 1,Male 0	+
Distance to Market	Mktdist	Continous	Km	+
Extension services	Extserv	Dummy	No=0, Yes=1	+/-
Number of cows owned	Cowned	Continous	Kenya shilling	+/-
Type of cows owned	TypCow	Dummy	Exotic=0, Indigenous=2	+
Group membership	Grpmbr	Dummy	No=0, Yes=1	+/-
Unit price of Hay	Haypr	Continous	Kenya shilling	+
Expenditure on Hay	ExpH	Continous	Average expenditure in Kenya Shilling	+
Unit price on Dairymeal	Dmpr	Continous	Kenya shilling	+
Expenditure on Dairymeal	ExpDm	Continous	Average expenditure in Kenya Shilling	+ +
Unit price by-products	ByPpr	Continous	Kenya-shilling	+
Expenditure on by-products	ExpByP	Continous	Average expenditure in Kenya Shilling	

Description of variables used in the Almost Ideal Demand Systems Model
'Table1…continued'

Unit price on By-products	Byprd	Continous	Kenya shilling	+
Expenditure on By-products	Expbyp	Continous	Average expenditure in Kenya Shilling	+
Unit price Minerals	Minpr	Continous	Kenya shilling	+
Expenditure on Minerals	Expmin	Continous	Average expenditure in Kenya Shilling	+
Total Expenditure on feeds	Texpfds	Continous	Average expenditure in Kenya Shilling	+

Objective3: To determine small-scale farmers decision making and extent of market participation for Cows feeds in Kiambu County.

To achieve the third objective the study used double hurdle model. Several models have been developed to handle censored data. The standard Tobin model (Tobin, 1958) has been widely used to estimate data and assumes market participation by a household is determined by latent variables that can be modeled as function of a vector of independent variables and an error term that is normally distributed. With both market participation decision and the extent of participation determined by the same equation, market participation observations in the Tobit model are assumed to result from a corner solution to the utility maximization problem. This may not be desirable if some factors on decision to participate in market do not impact on extent of participation directly. Likewise, some independent variables may have opposite impacts on the market participation decision and extent on participation. In either case, it is beneficial to separate the two decisions into a double hurdle model (Cragg 1971).

The double hurdle model assumes that farmers make two sequential decisions with regard to willingness of smallholder farmers to participate in the market and the extent to which they participate in markets sourcing for dairy cow feeds. Each of the two hurdles is conditioned by the household's socio-economic characteristics and variety-specific farmers' characteristics. Different latent variables were used to model each decision process in the double-hurdle model, with the probit model determining the probability that a household was willing to participate in the market and a Tobin model to determine the extent of participation. (Cragg 1971) specified the model as;

$Y^{*}_{i1} = w'_i \propto + \mu_i$ Decision to participate in the market

$Y^{*}_{i2} = x'_i \beta + \mu_i$ Extent of participation

$Y^{*}_i = x'_i \beta + \mu_i$ If $y^{*}_I > 0$ and $y^{*}_{i2} > 0$ ..... (10)

Where y^{*}_{i1} is a latent variable describing the farmer's decision to participate in the market and y^{*}_{i2} is a latent variable describing the extent of participation .The errors μ_i and ε_i are assumed to have a bivariate distribution with zero mean and a variance–covariance matrix. The empirical model can be written to show the probability of smallholders' market participation as a conditional on extent of participation can be written as,

$$P(y_i > 0) = \emptyset(w'_i\alpha)\emptyset\left(\frac{x'_i\beta}{\sigma_i}\right) \quad \text{..... (11)}$$

$$E(y_i > 0) = \emptyset\left(\frac{x'_i\beta}{\sigma_i}\right)^{-1} \int_0^{\infty} \left(\frac{y_i}{\delta_i\sqrt{1+\theta^2 y_i^2}} \emptyset\left(\frac{T(\theta y_i - x'_i\beta)}{\sigma_i}\right) \right) dy_i \quad \text{..... (12)}$$

For continuous explanatory variables, these marginal effects are used to calculate elasticities at the sample means. For the discrete or categorical variables, the marginal effects were used to calculate percentage changes in the dependent variable when the variable shifts from zero to one, ceteris paribus.

3.3.3 The empirical model specification for the double hurdle is shown below;

The Discrete choice model (Probit) is specified as:

$Y_{i1}(yes/no) = \beta_0 + \beta_1(Hedu)_i + \beta_2(Fsize)_i + \beta_3(Hage)_i + \beta_4(Hgder)_i + \beta_5(Hhsize)_i + \beta_6(Ext)_i + \beta_7(Cowned)_i + \beta_8(off\text{-}farmincms)_i + \beta_9(On\text{-}farmincms)_i + \beta_{10}(Credit)_i + \beta_{11}(Grpmbr)_i + \varepsilon_i$

The Outcome equation (Tobit) is given as follows:

$Y_{i2}(market\ share) = \beta_0 + \beta_1(Hedu)_i + \beta_2(Fsize)_i + \beta_3(Hage)_i + \beta_4(Hgder)_i + \beta_5(Hhsize)_i + \beta_6(Ext)_i + \beta_7(Cwowned)_i + \beta_8(off\text{-}farmincms)_i + \beta_9(On\text{-}farmincms)_i + \beta_{10}(Credit)_i + \beta_{11}(Grpmbr)_i + \varepsilon_i$

Table 2: Description of Variables in Double hurdle model

Variable	Code	Description	Units	Expected sign
Dependent variable				
Market Participation	MktPpt	Dummy	Yes = 1 No = 0	
Market share	MktShr	Continous	Percentage	+
Independent Variables				
On-farm incomes	On-farmincms	Continuous	Kenya shilling	+
Farm size	Fsize	Continous	Number	+
Off-farm income	Off-farmincms	Continuous	Kenya shilling	+
No. of cows owned	Cowned	Continuous	Number	+
HH Age	Hage	Continuous	Years	+/-
HH Gender	Hgen	Dummy	0= Female, 1= Male	+/-
HH Education level	Heduc	Continuous	Years	+/-
Household size	Hsize	Continuous	Number	+/-
Extension service access	Ext	Dummy	0= No, 1= Yes	+/-
Credit service	Credt	Dummy	0=No, 1=Yes	+/-
Group membership	Grpmbr	Dummy	0= No, 1= Yes	+/-

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1. Farm and farmer characteristics

This study assessed the farm and farmer characteristics in order to explain the farmer conditions at the time of the study. The results are presented in Table 3. The age of surveyed household heads ranged from 19 to 77 years. The average age for those that participated in market was about 45.22 while that of non-market participants was 55.13. This implied that farm Respondents in the region could be described as relatively young and within the economically active age bracket of between 20-60 years. This concurred with (Musah, 2013) that dairy farming as a business requires vigor and enthusiasm and majority of the tasks is labor intensive depending on the adopted system. As such this age group is best suited for the enterprise. This finding also concurred with Atuhaire *et al.* (2014) in a study on dairy farmers' production characteristics in Lake Victoria region that younger and middle aged household heads are strong, more dynamic and socially active with high energy levels of ambitions, expectations and high ability to take risks on investment for increased productivity.

The findings of the study indicated a variation in farming experience ranging between 1 to over 20 years. The more years a household had in dairy farming, the more experienced and skilled s/he was in managing dairy cattle in proper feeding for improved productivity. However, the failure of the older farmers to embrace new ways of doing things (Langyintuo and Mulugetta, 2005) may hinder market participation for cows' feeds.

The average household size was 5.32 members which were slightly above the Kenya's national mean figure of 5 members per household (KNBS, 2007). The smallest household size had 1member and the highest had eighteen members. Household size has been linked to the availability of "own" farm labor and it explained the family labor supply for production and household consumption levels (Alene *et al.,* (2008).

The proportion that hires a worker in their farm was few and those that did so were engaged in other non-agricultural activities mainly in formal employment. Unreliable tenure of farm workers and low wages resulting to abandonment of jobs without notice causing inconveniences.

Table 3: Farm and farmer characteristics by Market Participation

		Non-Market Participation = 15				Market Participation = 135				Pooled data =150			
Variables Continous	**Units**	**Mean**	**Std dev**	**Min**	**Max**	**Mean**	**Std dev**	**Min**	**Max**	**Mean**	**Std dev**	**Min**	**Max**
Age of Head	Years	55.13	10.91	27	72	45.22	13.53	19	77.00	46.21	13.59	19.00	77.00
Household size	Number	7.93	4.03	4.00	18.00	5.01	1.80	1.00	10.00	5.32	2.32	1.00	18.00
Farm size	Number	1.53	0.92	0 .25	3.40	0.13	30.00	2.36	3.22	0.13	30.00	2.27	3.08
Dairy cows owned	Number	3.27	1.03	2.00	6.00	7.65	6.90	1.00	60.00	7.21	6.68	1.00	60.00
On-farm milk income	Ksh	4344.67	1373.61	2660	7980	12974.20	12112.75	2660	103960	6306.4	4906.43	2660	103960
Off-farm income	Ksh	4000	1192.13	0.00	4500	8877.78	7930.90	0.00	65000	5390	3729.88	0.00	65000

The sampled respondents had an average farm size of 0.13 hectares. For those who participated in cow feeds market the farm size ranged from an eighth to 3.4 hectares as indicated in Table 3. The non-market participants had relatively bigger size of land sizes compared to potential market participants. However, the recommendation of one acre per mature cow and heifer (MLD, 1991) was not achieved. The findings collaborate with Wambugu (2000)) in a study in Kiambu district, who noted that on average 0.4 ha was under napier grass, most of the farms supplied less than 6.4 tons of napier grass dry matter per year. Each cow therefore had less than 3.2 tons of dry matter per year (9 kg DM/animal/day) available for an average herd of two cows per farm. Staal *et al.* (1997) in their study concurred with this study that purchased fodder and feed were a crucial component of smallholder dairy production systems in Kiambu County, with 60% of the zero-grazing farmers relying on feed purchases. Baltenweck and Staal (2002) found a low association between land size and use of improved dairy practices that led them to conclude that dairy production 'appears to be an enterprise open for even those with very small landholdings'.

The market participants for cow feeds were found to have a higher number of dairy cows owned compared to non-market participants as shown in Table 3. The small dairy producers bought crossbreed cows mainly Friesian, Ayrshire, and Guernsey from neighbors and or upgrade the local cows using artificial insemination (AI) programs. There were more advanced farmers engaging in more intensive dairy systems thereby rearing hybrid cows that were sourced from other Counties or even from abroad.

The results also indicate that average monthly income from sale of milk by the respondents was Ksh.6306.4. The highest earner per month from milk sales received Ksh.103960 while the lowest had Ksh. 2660. It was also noted that non-market participants had lower farm incomes from milk sales compared to market participants for dairy feeds. This was attributed to the fact that more incomes from milk sales enabled smallholder farmers to feed their cows better by purchasing feeds from the markets. This agreed with findings by Mulford (2013), that the number of improved cows owned, and the amount invested in feed concentrates and artificial insemination were strongly correlated with milk sales volumes in both 2004 and 2007 study conducted in Kenya.

Off-farm income had an overall mean of K.sh. 5,390, the least amount earned by farmers was nil and the highest K.sh.65, 000 per month. The non-market participants had lower off-farm income

compared to market participants. Indeed, most Respondents in the study area either worked as hired laborers in tea estates or dairy farms within and outside Githunguri and Lari Sub-Counties or depended on remittances from relatives in other areas. The interviewed respondents were engaged in different activities of which dairy farming ranked first, pensionists second followed by others like 'matatu' or motorbike passenger service transport, which they combined with dairy farming. Omiti, *et al.* (2009) had earlier confirmed in a case study conducted in rural and peri-urban areas in Kenya and noted that there was a large share of working class people who were engaged in dairy farming as an enterprise.

Table 4: Educational level of Household Heads

	Non-market Participation = (10%)		Market Participation = (90%)		Pooled data (100%)	
Variable (Dummy)	Frequency	%	Frequency	%	Frequency	%
Level of Education						
Not gone to school	4.2	28.3	7	5.2	11.2	7.5
Primary	6.4	42.7	12	8.9	18.4	12.3
Secondary	3.6	24	56	41.5	59.6	39.7
Tertiary college	0.8	5	49	36.3	49.8	33.2
University	0	0	11	8.1	11	7.3

Table 4 presents the results of the level of education of the household heads. The overall percentage of the sampled Respondents indicated that 39.7% had secondary level of education, while those with tertiary level of education were 33.2%. Majority of the Respondents not participating in markets had attained at least primary and a minority had secondary level of education. Among the market participants, a higher number had attained secondary and a lower number had attained tertiary and University level of education. This was attributed to the fact that small scale farmers have a tendency of taking up farming activities in a professional manner

as their education level increases to achieve their set goals. These findings were similar to those of Reimers and Klasen (2012) who noted that returns due to secondary education were higher than primary education because of the ability of farmers to make better decisions and choices about combinations of inputs to obtain maximum output.

Results indicated that gender and group membership also had the potential to influence the decision to participate in markets for dairy cows feeds and the results are presented in Table 5. The overall results indicated that there were more male than female headed respondents. Majority of the non- market participants were female. Male headed homes had higher market participation for dairy cows feeds than female headed ones. This was attributed to the fact that female farmers are more occupied with household chores which include dairy farming activities. Similar results were found by Tanga *et al.* (2000) that female contributed more labor in the area of feeding, cleaning of bans, milking, butter and cottage cheese making and sale of dairy products. However, such constraints as lack of capital and poor access to institutional credit and extension service, affected female participation in dairy production and market earning power.

The overall results of the sample on group membership indicated that majority of the respondents were members of a group especially the dairy co-operatives. This was attributed to the fact that farmers kept close contact with the dairy co-operative society because of the variety of services it offered namely milk marketing, feed supply, A.I. and veterinary clinical services. However, though some non-market participants belong to same groups, majority were in-active registered members of the dairy co-operative society. Majority of the respondents who participated in markets for cow feeds were active members of Githunguri dairy co-operative society with very few being non-members of any grouping. This result concurred with Wambugu (2000) and Staal *et al*. (1997) that at least 50% and 59% of the farmers across all the locations in Kiambu district were members of the dairy co-operative society, out of which 69% and 68% respectively were active. The co-operative was an important source of information to farmers in all locations.

Table 5: Gender and group membership percentage distribution

	Non-Market Participation= (10%)		Market Participation = (90%)		Pooled data =100%)	
Variables (Dummy)	Frequency	%	Frequency	%	Frequency	%
Gender						
Male	5	33.3	87	64.4	92	61.3
Female	10	66.7	48	35.6	58	38.7
Group membership						
Yes	12	80.0	92	68.1	104	69.3
No	3	20.0	43	31.9	46	30.7

The overall results in Table 6 indicate that majority of the respondents reside within1-2km from the trading centres. Majority of the market participants for cow feeds resided in close proximity, while those at far distances above 4km from trading centres participated in markets occasionally. Location from the trading centre and milk collecting centres here played a role of a proxy for information access (extension service) and cow feeds selling premises. Observations from the study indicated a very poor state of the road networks in Githunguri and Lari Sub-Counties. This had a negative impact on small scale farmers because collection of forage from the sources requires transport. Different modes of transport were being used to collect forage from the sources to the dairy units. The greater the distance from trading centres and the poor state of the road influenced the cost of transporting feeds for the small scale farmer.

According to Ter-Hemen (2015) improved roads benefit a variety of agricultural and other rural subsectors, infrastructure is particularly important to dairy development. The cost of transporting feeds has an implication on the milk production costs and the maintenance of high levels of milk production throughout the year. This concurred with Nifeg (2011) who contended that transportation was essential for marketing and enhanced the ability of poor small scale dairy farmers to reach markets. Their ability to actively engage in markets posed a pressing dairy development challenge. Modes of transporting fodder in the study area included pickup vehicles, with majority using bicycles, motor bikes and walking animals/humans. This was similar to

findings by Prain, Karanja, and Lee-Smith (2010), that urban dairy farmers in Nakuru transported fodder using mostly bicycles, followed by walking humans/animals.

Table 6: Distance/Location of the farm from the market by market participation

	Non-Market Participation=10%		**Market Participation =(90%)**		**Pooled data =(100%)**	
Variable(Continous)	Frequency	%	Frequency	%	Frequency	%
Distance						
<1km	1	6.7	86	63.7	87	58
2-4 km	4	26.6	30	22.2	34	22.7
>5 km	10	66.7	19	14.1	29	19.3

The market participants for dairy cows feeds were found to have an overall higher percentage of contacts with extension officers compared to non-market participants as shown in Table 7. A combination of co-operatives and government extension service providers was observed to have disseminated information on better feeding of the dairy cattle and thus an increase in market participation for feeds. Wambugu (2000) in a similar research in Kiambu district concurred with this study that Government extension agents put a lot of emphasis on feeding since it had been shown to be a major factor limiting milk production in the district (Omore *et al.*, 1996; Omore, 1997; Staal *et al*., 1997).

Table 7: Extension service contact with household by market participation

		Non-Market Participation = (10%)		Market Participation = (90%)		Pooled data = (100%)	
Variable (Dummy)		Frequency	%	Frequency	%	Frequency	%
Very often	No	**0**	0	3	3.0	3.0	2.0
	Yes	0	0	69	50.4	69	46.0
Less often	No	0	0	50	37.0	50	33.3
	Yes	3	20	13	9.6	16	10.7
Hardly ever	No	6	40	0	0	6	4
	Yes	6	40	0	0	6	4
Total		15	100	135	100	150	100

4.1.1: Feed resources, feed conservation practices and supplement choice decision by Respondents

The respondents were asked to rank the top fodder grown in terms of acreage in the farm. The comprehensive results are presented in the graphical representation in Figure 3. The results indicated that napier grass (*Pennisetum purpureum)* was ranked first as the most preferred grown by the respondents, followed by *Leguminous spps* most common, *desmodium* and *Lucerne*. Fodder trees ranked third and *grassess ranked least.* A major conclusion from the results and field observation was that napier grass was most prefered because of its quick regeneration after cutting, its lifespan in the farm of upto three years and little management aspects. In addition it had a positive interaction with other crops in the sense that it was planted along terraces for soil conservation. The only major constraint farmers faced with napier was the Smart disease which Kenya Agricultural and Livestock Research Organiztion (KALRO) came up with immune varieties. Fodder trees grown by farmers were mainly *Tithornia diversifolia*

which notably was said to add nutrients to the soil, Calliandra and sesbania as fence material for boundary de-markation, and supplied the residents with firewood, shade and timber.

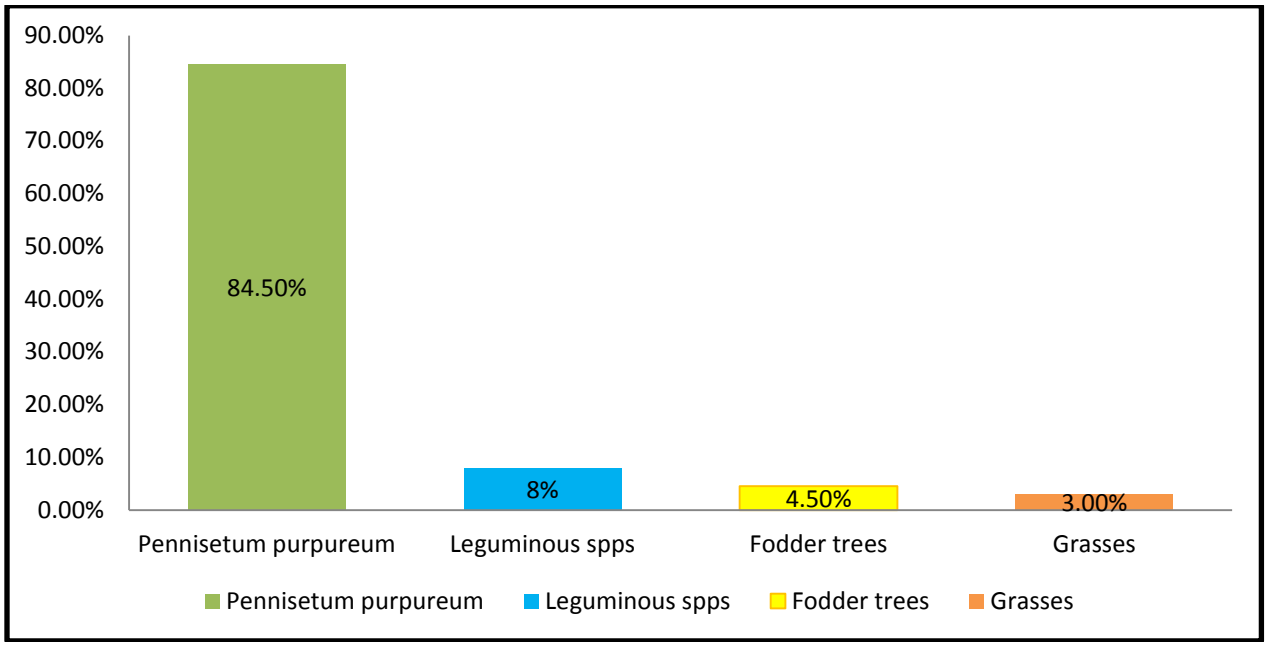

Figure 3: Type of fodder Grown by Respondents

Majority of farmers did not practice feed conservation due to various constraints as indicated in the results given in Table 8. The market participants for dairy cows feed indicated lack of materials for conservation as the main reason for non-adoption of conservation practices citing ownership of small parcels of land. The non market participants attributed their lack of adoption of conservation practices to lack of materials. Small scale farmers with large portions of land preferred selling excess fodders grown rather than conserving it. The low adoption of these practices was attributed to the limited availability and contact with extension workers and inadequate knowledge or lack of interest about implementing the conservation methods. According to Pen et al. (2009) farmers failed to take advantage of proven technologies aimed at improving feed quality. They feed low quality roughage in the form of dried maize stover and yet poor nutrition results in low growth rates and low reproductive performance. The study findings agreed with Njarui *et al.*(2011) in a study in lower Kangundo and Mwala region in Machakos district, Kenya, that though virtually all farmers (97.5%) interviewed practiced some

form of feed conservation. However the quantity conserved was little and insufficient to sustain their herd during period of feed scarcity.

Table 8: Constraints that hinder Feed conservation by Respondents

	Non-Market		Market		Pooled	
	Participation = (10%)		Participation = (90%)		data = (100%)	
Variable	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Small land size	1	0.7	12	8.9	13	8.7
Scarcity of feeds	8	5.3	95	63.0	103	68.7
Lacks Knowhow	4	2.6	23	15.1	27	18
Mould/rotting of feeds & others	2	1.4	5	3.0	7	4.6
Total	15	10	135	90	150	100

The main supplements bought by the feed market participants are presented in Table 9. The results revealed that majority of the respondents acknowledged importance of supplementing cows feeds and therefore bought grain supplements mainly dairy meal followed by by-products (being substituted accordingly) and mineral salts. The implication of the results was that farmers had adapted to other alternative cow feeds (wet yeast, brewer's wastes and pineapple pulp) which acted as substitutes when grain concentrates prices hiked. The substitution effect states that an increase in the price of a good will encourage consumer to buy alternative goods. A similar observation by Omondi (2013) indicated that dairy farmers from the Eastern part of Uganda were cashing in on the cheap locally available grains discarded after extraction in the process of making beer to feed their cattle. This increased milk yields at a time when the prices of commercial feeds across East Africa were hitting unprecedented highs. The proportion of respondents who did not offer supplements (10.1%) cited drastic price increases of commercial feeds as a main limiting factor. During the survey period, the cost of dairy meal had increased by over 60%, from Ksh. 1600 (US$ 16.67) to slightly over Ksh. 2100 (US$ 21.87) for a 70 kg bag of dairy meal due to increased taxation on imported ingredients. However, this was not matched with increased price of milk thus becoming un-economical to offer concentrates. This agreed

with Ter-Hemen (2015) that the high cost of concentrates and the declining milk to concentrate price ratio makes it difficult to feed adequate concentrates regularly resulting in low productivity. The quantity of supplements offered was generally low and the amount was fixed (usually about 2 kg) each milking time throughout the lactation period. This was not adjusted to specific nutrient required by the cows based on milk production. Similar findings were also reported by Omore et al. (1996) in the traditionally dairy region of Central highlands of Kenya. As a result, the farmers did not realize the full potential in milk production from their cows.

Table 9: Type of Supplements preferred/bought by Respondents

Variable	Frequency	Percentage
Grains concentrates (Dairy meal, pollard, maize/wheat germ, bran etc) and mineral	79.5	53
By-products (Brewers waste, wet yeast, brewers waste) and minerals	20.6	13.7
Grain concentrates Vs by-products and minerals	34.8	23.2
None feeding of concentrates	15.1	10.1
Total	150	100.0

4.1.2 Factors determining decision to participate in feeds markets by Respondents

Results of factors determining small scale farmers' decision to participate in feeds market are presented in Figure 4. The majority of respondents participating in markets for dairy cows feeds considered price fluctuations as the main reason for their decision on choice of feed. Those that considered their 'own' needs in terms of requirements by the cows owned were at 27.4%. Social capital among the farmers enabled them to share information and learn from each other was at 18.3%. The factor ranked last was the extension service provider's advice that farmers considered while making choice on what to purchase as cows feeds. The implication of the

results was that high cost of dairy cows feeds remained the highest challenge to majority of the farmers and highly influenced their decision on type of feeds they purchased for their dairy cows.

Until 1997 the minister charged with livestock had vested powers to control feed prices. The Kenya farmers Association (KFA) enjoyed a legal monopoly in the marketing of animal feeds. To reduce the cost of animal feeds, government waived the duty on imported feed ingredients and no additional taxes were levied on manufactured feed. Price deregulation in 1987 resulted in increased participation in processing and distribution of animal feeds by both the private sector and co-operatives throughout Kenya (Mbugua, 1999). Prices of dairy cow feeds should be consumer favorable to enable affordability.

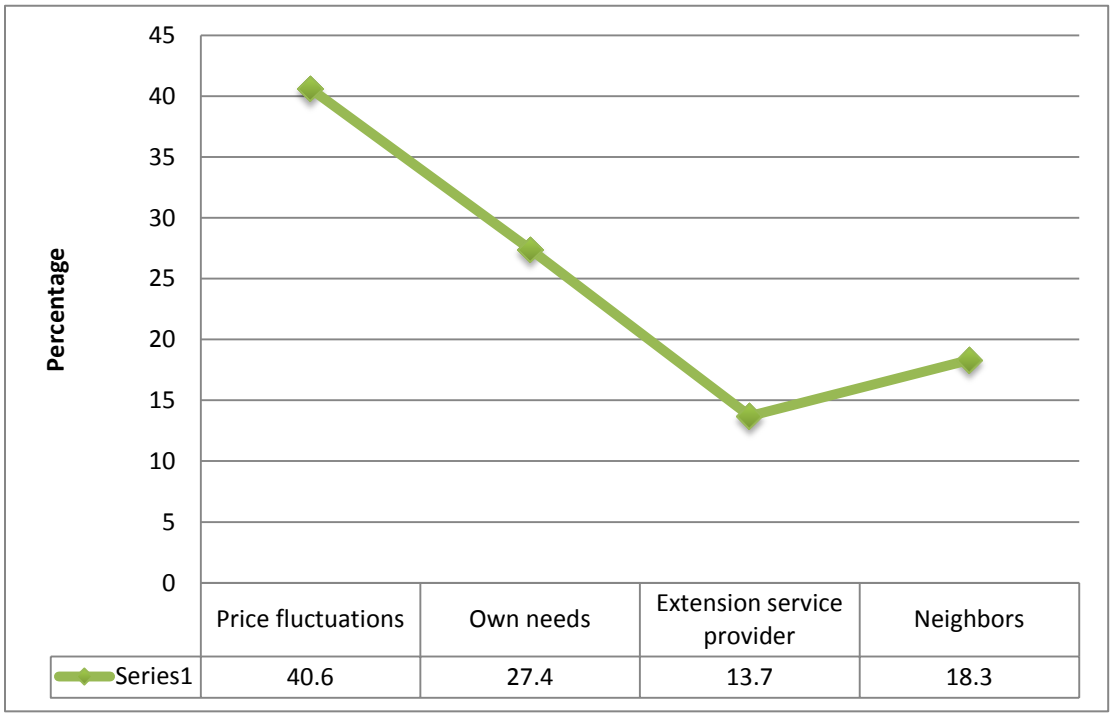

Figure 4**: Determinant of decision to participate in feeds markets by Respondents**

4.1.3: Feed formulation practices by Respondents

Farmer uptake of the existing technologies and upcoming initiatives played a pivotal role in increasing productivity and reducing feed prices. The result in Table 10 indicates that majority of the farmers not participating in markets for cows' feeds did not formulate any feeds due to lack

of knowhow and others lacked raw materials to formulate either due to high ingredients costs or bad weather conditions. Though this category of farmers who did not participate in markets were using crop residues, maize husks from own crop and fodder trees or banana plantains, these blended well to provide nutrients required. However, more farmers formulated feeds to reduce budget share of feeds and to improve on quality of feeds. Respondents who participated in markets and did not formulate had varying reasons which included high cost of inputs, lack the raw materials and inadequate knowhow to formulate. Farmers continued to disregard the uptake of upcoming livestock feed technologies. Therefore feed formulation practices had not enhanced lowering of feed prices to realize effects towards reduced budget allocation on feeds. Similar findings were also reported in a manual GOK (2001) that cost of feeds still account for more than 50% of the total production costs.

Table 10: Feed formulation Practices by Respondents

	Non-Market Participation =10%		**Market Participation = (90%)**	
Variable(Dummy)	Frequency	%	Frequency	%
Lacks knowhow	5	33.3	13	9.6
Lack /High Cost of inputs	7	46.7	28	20.7
To reduce cost of feed	1	6.7	53	39.3
To improve feed quality	2	13.3	41	30.4
Total	15	100%	135	100%

4.1.4: Factors influencing decision to participate in feed markets by Respondents

A farmer's decision to participate in markets for dairy cows feed is informed by several reasons as shown by results in Figure 5. In the study, highest percentage of the respondents acknowledged scarcity of home grown feeds due to unreliable climatic conditions forced them to buy feeds from the markets especially hay and concentrates. Farmers attributed price of outputs

to be the main reason they bought feeds basing it on return on investment (ROI) was at 5%. Similarly some farmers had excess napier grass production and they sold it to neighboring farmers using ocular measurement method. 10% of the respondents relied on retailers for information on which best feeds to buy for their dairy cows. These results implied that farmers had not embraced use of irrigation systems and technologies like hydroponics fodder to provide feeds throughout the year. During rainy seasons milk was in surplus and farmers were offered very low prices for outputs by buyers, likewise farmers invested less in feeds as they depended on the abundant lush pastures.

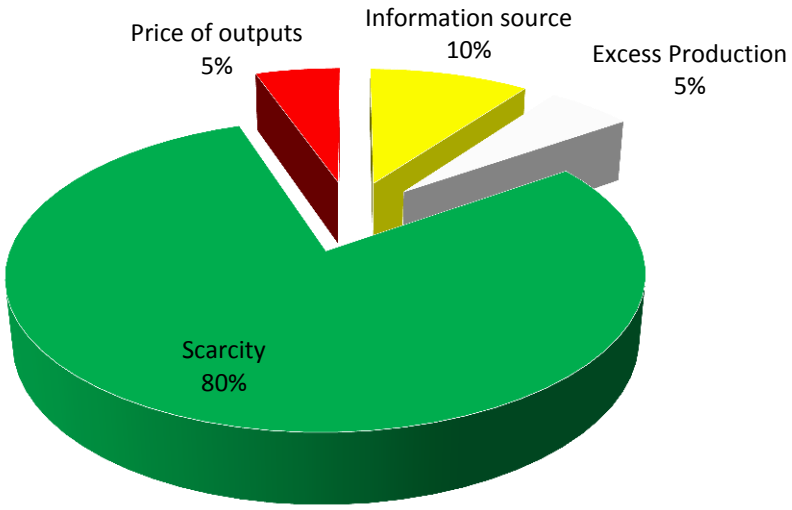

Figure 5: Decision to Participate in Markets for Dairy Cows Feeds

4.2.1: Almost ideal demand system model of Kiambu County Dairy feeds.

This section presents results of the Almost Ideal Demand System (AIDS) model. Table 11 presents descriptive statistics related to the data set on capital expenditures on cows' feeds by Respondents. In the study the following four feeds commodity aggregates were used: fodders namely; Napier grass, leguminous spps, other grasses, crop residues, fodder trees, hay, maize stocks, straws, Concentrates namely**;** Dairy meal, pollard, maize germ, Bran, cotton seed cake, wheat germ; By-products namely; molasses, pineapple pulp, brewers waste, yeast, fish meal, and

Minerals. The prices for the commodity per unit were proxied by the cost of these commodity aggregates from the retail market.

Table 11: Descriptive statistics on Per Capita expenditures (Ksh. /Month) on cows' feeds by Respondents

Per Capita Expenditure(ksh./month)	Mean	Standard deviation	Minimum	Maximum
Total expenditure on cow feeds per 50kg	17767	19219.737	750	149000
Age	46.21	13.590	19	77
Household size	1.39	.942	1	5
Farm size	2.2736	3.07687	0.13	30.00
Education	00.00	00.00	0	00.00
Distance (KM)	1.51	0.740	1	8
Extension service contacts	00.00	00.00	0	00.00
Unit price for hay/bail	119.73	47.472	0	150
Expenditure on hay	9178.4	10660.528	0	75000
Gender	00.00	00.00	0	00.00
Unit price for dairy meal	1927.3	1634.483	0	20000
Group membership	00.00	00.00	0	00.00
Expenditure on dairy meal per 70kg	16012.	18197.938	0	140000
Expenditure on by-products per kg/Ltr	828.00	2234.390	0	12000
Unit price on minerals per kg	132.73	16.725	110	150
Expenditure on minerals	926.60	909.346	150	9000

Table 12 contains the parameter estimates of the AIDS model in equation 1 by using the data obtained from the field survey. The results indicated that the budget share for cow feeds was highest on concentrates followed by fodders, by-products and least was on minerals and vitamins

respectively. The parameter estimates were then used to estimate the different Marshallian and Hicksian elasticities using equations 8 and 9 respectively.

Table 12: Parameter estimates of the AIDS model

Variable	**Price**				**Mean budget share**
Type of expenditure	Fodders	Concentrates (Manufactured feeds)	By-Products	Minerals	
Fodders	0.152				0.38
	*(5.98)***				
Concentrates (Manufactured feeds)	-0.12 *(-2.85)***	0.143 *(5.97)*	0.417 *(7.24)***		0.46
By- Products	-0.006 *(-0.74)*	-0.115 *(1.38)**	-0.004 *(0.47)*		0.14
Minerals & vitamins	-0.065 *(-2.47)***	-0.021 *(-0.86)*	-0.004 *(-0.21)*	0.081	0.02

t-ratios are in parentheses, where: *, **, *** denotes significance at 10%, 5% and 1% respectively.

4.2.2 Hicksian or Compensated elasticities for Dairy cows feed in Kiambu County

Hicksian elasticities were reduced to contain only price effects, and were thus compensated for the effect of change in the relative income on demand. By using the parameter estimates in Table 12 and Formula 8, results are shown in Table 13. Estimating different elasticities for the cow feeds suggested that own price and incomes were the predominant factors determining consumer choice/demand for feeds. Compensated own price elasticities of all four dairy cows feeds were relatively inelastic. The value of compensated own price elasticity for by-products was the most elastic, followed by concentrates, fodder then minerals and vitamins. This meant that a 1% increase in prices of each feed reduced its demand differently and this information can be useful

in setting of prices by the feed providers. Except for the cross-price elasticity between fodder and minerals, and vice versa, all other cross-price elasticities had a positive sign meaning they were substitute goods. Regarding the cross-price elasticities, the consumption of by-products showed the strongest substitution response for the price of concentrates, whereas the consumption of concentrates was not as responsive to the price of by-products. The results indicated that when concentrates prices rise, smallholder farmers tend to reduce concentrates consumption and demand more of the by-products. However, when prices of by-products changed these did not affect demand for concentrates. The second strongest substitute response was the consumption of fodder for the price of concentrates; similarly consumption of concentrates was also responsive to the price of fodders. This results and observation from the field study indicated that when forages and other crop residues were in plenty due to rains, farmers reduced consumption of concentrates. Similar findings were reported by Njarui, (2011) in a study in semi-arid region of Eastern Kenya. That, sweet potatoes vines or legume residues from cowpea and pigeon pea was not restricted during the rainy season when they were abundant. All the other cross-price elasticities in the study were less than 0.1.

Table 13: Hicksian elasticities/Compensated of Kiambu County Dairy Cows feeds, AIDS model

Variable	**Fodders**	**Concentrates (Manufactured feeds)**	**By-Products**	**Minerals& vitamins**
Fodders	**0.161***	0.149*	0.139*	-0.172
Concentrates (Manufactured feeds)	0.173	**-0.277**	0.375*	0.060
By- Products	0.087*	0.053*	**-0.305***	0.043*
Minerals & vitamins	-0.193*	-0.103*	0.094*	**0.020***

* Indicates significance at the 5% level.

4.2.3.1: Marshallian price or Un-compensated elasticities and Expenditure elasticities for Dairy cow feeds in Kiambu County

The estimates of Marshallian own price elasticities and expenditure elasticities are given in Table 14. The own-price elasticities were all found to be negative as expected. In absolute terms the value of elasticity was found to be lowest for minerals followed by those for by-products, fodders and concentrates respectively. Of the four items concentrates was the most expensive followed by fodders, by-products and minerals. As such the results were regarded as expected since the least expensive item was found to have the lowest elasticity. The value of expenditure elasticity was found to be highest for concentrates followed by fodder. The reason for this was that concentrates were bought in retail shops in kgs and prices fluctuated and were maintained at certain levels as a result of availability of ingredients and government policies. However fodders were planted by farmers and were sold on ocular estimates or per acre. Fodders supplies were only affected by rain shortage and were often in surplus during rainy seasons. The cross-price elasticities for concentrates, fodders, and by-products showed substitutability. The extent of substitutability was highest between concentrates and fodders. Concentrates and fodders are meant to be complements; however, most small scale farmers often reduce completely amounts of concentrates when fodders are in plenty. Second as substitutes were between by-products and concentrates, similar findings by Shingoethe (2008) suggested that the highly digestible fiber in distiller dried grains which were similar to brewers' wastes, also served as a partial replacement for forages and concentrates in diets for dairy cattle although small scale farmers usually replaced concentrate ingredients completely.

4.2.3.2: Expenditure elasticities for Dairy cows feed in Kiambu County

The calculated expenditure elasticities (by using equation 8) are also indicated in Table 14. Expenditure elasticities for all the feeds were less than one, and were considered necessary goods. Although the expenditure elasticity for concentrates was less than one, it was close enough to one, which was the cut-off point between luxury and necessary goods. Observations from the field survey indicated that majority of small scale farmers gave concentrates (dairy meal) to lactating cows only during milking time. The relative low expenditure and inelastic price of minerals and vitamins indicated that changes in its price did not bring about significant shift in demand and that small scale farmers considered it an inexpensive, necessary good. This provided mainly calcium and other important minerals which are major components in milk synthesis. Similar findings by Njarui *et al.* (2011) observed that mineral supplements in form of blocks and molasses were also available in all farms where dairy supplements were provided to the cows.

Table 14: Marshallian/Uncompensated elasticities of Kiambu County Dairy Cows feeds, LA/AIDS model

Type of expenditure	**Marshallian Price**				**Expenditure elasticities**
	Fodders	Concentrates (Manufactured feeds)	By-Products	Minerals	
Fodders	**-0.558**	0.451	-0.064*	-0.5*	0.758*
Concentrates	-0.261*	**-0.790***	0.21*	-0.168	0.983*
By- Products	0.040*	-0.084*	**-0.37***	-0.037*	*0.542*
Minerals/ vitamins	-0.19*	0.008*	-0.05*	**-0.31***	0.325*

* Indicates significance at the 5% level.

4.3.1: Factors influencing decisions of Small-scale farmers to participate in Markets for dairy cow feeds in Kiambu County

To identify factors influencing small-scale farmers decision to participate in the market for dairy cows feed, the probit model was estimated and the results presented in Table 15. The Probit model was estimated using the random effect maximum likelihood estimation method (random effect models have an assumption that individual effect is uncorrelated with all other explanatory variables). The age of the small scale farmers had a negative significant effect on the decision to participate in the market for dairy cows feed. An increase in age (years) decreased the probability of participating by 0.006 (0.06%). The reason behind this was that, though age of the household head played an imperative role as a proxy for experience in farming and uptake of new technologies, older farmers tended to be risk averse and preferred practices they were familiar with. Randela *et al.* (2008) also observed that younger farmers were expected to be progressive, more receptive to new ideas and to better understand the benefits of agricultural commercialization. In contrary Omiti, *et al*. (2009) argued that experience due to age was expected to improve the intensity of market participation. From the field study some observed reasons for less market participation included; increase in other cash needs like fees for their children, less physical strength to do farm activities and retirement from employment thus less incomes.

The level of education (years spent in school) by the household head had a positive coefficient for the market participation probability model and was statistically significant at 5%. This meant that an increase in years spent in school was associated with a (52.9%) increase in the probability of participating in markets dairy cow feeds. This observation agreed with the expectation of Makhura *et al.* (2001), Enete and Igbokwe (2009), Randela *et al.* (2008), who argued that education, endowed the household with better production and managerial skills which could lead to increased participation in the market.

The probability of male farmers participating in markets for dairy cows feeds was significant at 5% all other factors held constant. This implied that male headed families had a higher probability of market participation because majority were cash providers and usually made the decision on type of feeds to buy, while females and children engaged only in farming activities.

Similar results were observed by Tanga *et al.* (2000) and Adesina *et al*. (2000) who found that female contributed more labor in the area of feeding, cleaning of bans, milking, butter and cottage cheese making and sale of dairy products. Moreover, since women in the rural areas formed majority of the population undertaking farming activities, they faced socially conditioned inequities in the access, use and the control of household resources. This may affect female participation in dairy production and markets earning power. Narrowing the gender gap in this case may be achieved through collective action complemented by the necessary commitment by the Central and County Governments and all key players.

Table 15: First hurdle econometric result on Factors influencing the decision of Small-scale farmers to Participate in Markets for dairy cow feeds in Kiambu County

Variable	Marginal effects/elasticities	Standard error	P>(z)
Farm size	0.108	0.119	0.365
Age	0.006	0.002	**-0.004*** **
Education level	0.529	0.216	**0.014** **
Gender	0.601	0.334	**0.072***
Household size	0.003	0.015	0.825
Off income farm	0.000	0.000	0.810
On farm income	0.139	0.122	0.254
Extension service	0.058	0.057	0.306
Cows owned	0.00	0.005	0.617
Credit amount	0.0071	0.011	0.526
Group participation	0.0298	0.058	0.608
Constant		0.356	0.538

Log likelihood = -49.362901; log likelihood $\chi 2$ =34.95; R^2=0.2615; where: *, **, *** denotes significance at 10%, 5% and 1% probability level respectively.

4.3.2 Respondents Extent of Market Participation

The second stage of the double hurdle model measures extent of market participation among the potential market participants. The random effect censored regression model (Tobin model) was applied in order to be consistent with the Random effect probit model. The number of observation that was censored was 34 and the uncensored observations were 116. Results in Table 16 indicate that farm size was found to be negative and significant. One hectare increase in farm size decreased the probability of participating in markets to purchase cows feeds by 5.4% all else held constant. This suggested that the larger the farms the less likely the farmer was willing to participate in market to purchase cows feeds. The interpretation for this was that large farm owners had more flexibility in their decision making, because they had more opportunity to plant fodder crops like Napier and utilize crop residues from other planted crops as feed for the dairy cows. Similar results were observed by Nowak (1987) who found out that smaller farms had lower levels of land use diversification. As competition arose, there was a limitation to the number of uses applicable on the piece of land unless the uses were complementary. Beshir (2013) also found out in a study in Ethiopia that farm size influenced negatively the probability of adoption of improved forages at 5% probability level. This was due to lack of space, a requirement for the application of the technology to make any economic sense.

In the case of on-farm income from milk sales (incomes) positively influenced the decision behavior of the farm Respondents and their extent of participating in markets at 5% probability level. The possible justification for this result was that on-farm incomes from milk sales might be used to utilize and enable adoption of new technologies. In this case the use of manufactured feeds and forage development and make feed rations to enhance productivity of the dairy cows.

Results indicate that on-farm incomes from sale of crops negatively influenced the decision of farm Respondents and their extent to participate in markets at 5% probability level. An increase by 1 unit in sales (incomes) from crops decreased the probability of participating in markets to purchase cows feeds by 11.8 %. The negative effect of income from crops implied that the more gains the farmer acquired from sale of crops was used to utilize labor, fertilizers and high yielding crop varieties, thus reducing extent of potential market participation for dairy cows feeds. However, intensive discussions with farmers on the disparity between crops and farmer market participation revealed that choice of enterprise based on returns and land size influenced

the inputs that were purchased. Cash crop farming mainly tea and dairy farming activities in the region were to some extent substitutes instead of being complements. Though both are practiced together by some farmers there was bias for either one in intensification. When respondents earned more from crops tea, coffee and others they tended to shift their attention from intensive dairy farm activities hence low demand for cow feeds. This implied that there was a trade-off between crops and dairy engagements with respect to the income gain.

The number of extension contacts (access) by the small scale farmers was significant at 10% and had a negative probability of market participation. An increase in the number of contacts farmers made with the extension workers decreased the probability of participating in markets to purchase cows feeds by 78.1%. This finding was rather inconsistent with expectation and the explanation in support of it would be that access to information did not necessarily mean its application because there were other factors to consider like money access, equipments and inputs, and land (space). The negative effect of extension contacts implied that perhaps farmers with extension contact did not strictly adhere to the improved farm practices. This is since extension agents are reported to be constrained in embarking on effective supervision and no corrective measures are taken. The findings concurred with Martey *et al.* (2012) and Musah (2013) that lack of effective monitoring in ensuring effectiveness in utilization of improved technology passed on to the farmers by extension workers attributed to their low adoption. Other considerations maybe the high cost of feeds, ignorance by farmers and distance from trading centres. The results pinpointed the importance of monitoring and evaluation of improved practices taught to farmers to ensure their implementation. This should be given due attention in the extension service provision to positively influence farmers' market participation decision to enhance productivity of dairy cows in the study area.

Table 16: Second hurdle econometric results of Small-scale farmers Extent of Market Participation

Variable	**Marginal effects/elasticities**	**Standard error**	**P>(z)**
Farm size	0.054	0.018	**-0.003*** **
Age	0.005	0.004	0.276
Education level	0.019	0.080	0.809
Gender	0.089	0.128	0.487
Household size	0.013	0.033	0.688
Off-farm income	0.000	0.000	0.452
On-farm income/milk	0.000	0.000	**0.022** **
On- farm income/crops	0.118	0.054	**-0.031** **
Extension service	0.781	0.463	**-0.091***
Cows owned	0.00	0.005	0.617
Credit amount	0.025	0.024	0.292
Group participation	0.029	0.058	0.608
Constant		0.356	0.538

Log likelihood =-774.82547; log likelihood $\chi 2$ =61.46; R^2=35.7%, where: *, **, *** denotes significance at 10%, 5% and 1% probability level respectively.

CHAPTER FIVE
CONCLUSIONS AND RECOMENDATIONS

5.1 Conclusions

The study aimed at characterizing the small scale dairy farmers, identify the demand of dairy cow feeds and determine the small scale farmer decision and extent of participation in markets for dairy cow feeds in Kiambu County, Kenya. Fodders, concentrates and minerals are a crucial component for smallholder dairy production systems in Kiambu County. Over 80% of farmers practice zero-grazing and rely on purchased dairy cow feeds. In the study area 90% of the farmers participated in market to purchase feeds for their dairy cows while 10% did not.

Conclusions based on farmers characteristics from this survey were that, majority of the small scale farmers were of youthful, strong, active and dynamic to undertake dairy enterprise. The household size membership was adequate and therefore family labor was available. However, a few employed farm help to assist in milking and sourcing for feed for the dairy cows. Farm size was limiting to most farmers for planting fodder crops and zero grazing system was applied by majority of the Respondents. Farmers with higher incomes from milk gave their cows concentrates, by-products (alternatively), including minerals. Majority of market participants had secondary and above level of education and were in a position to make better decisions and choices about dairy cows feeding. On gender, male headed Respondents participated more in feeds markets unlike the female headed ones. Women seemed more occupied with farm activities and chores. Majority of the market participants were registered members of the Dairy co-operatives in the area.

Distance to markets and poor state of feeder roads hindered more participation in feeds markets. Most small scale farmers based their decision to participate in markets to scarcity of feeds as a result of unreliable weather and ownership of small land sizes (on average an eighth of a hectare). Non-market participants with large farm sizes integrated fodder (mainly napier) growing with other crops residues as alternative forage to concentrates feeding. Majority of respondents on factors determining decision to participate in feeds markets attributed scarcity of feeds from own resources as the main reason. Stockists/retailers gave information to respondents on what feeds can improve productivity of their cows. Others made decisions based on attributes

on price of outputs. Respondents with excess production of Napier sold it to their neighbors at farm gate.

On demand for cow feeds the Hicksian/Compensated own price elasticities for the four dairy cows feed types were relatively inelastic demand. The value of compensated own price elasticity for by-products was found to be the lowest, then minerals, concentrates and fodder respectively. Regarding the cross-price elasticities, the consumption of by-products showed the strongest substitution response for the price of concentrates, whereas the consumption of concentrates was not as responsive to the price of by-products. The conclusion from the results was that when concentrates prices rise, smallholder farmers tend to reduce its consumption and demand more of the by-products. However, when prices of by-products change they do not affect demand for concentrates.

The Uncompensated/ Marshallian own price elasticities in absolute terms were less than 1 in absolute value, meaning that all goods were inelastic. The own price elasticities were found to be lowest for minerals followed by by-products, Fodders and finally concentrates respectively. The calculated expenditure elasticities on cow feeds for Kiambu County were found to be highest for concentrates followed by fodder. Expenditure elasticities for all the feeds were found to be less than one, indicating that they were considered necessary goods. Conclusions on the expenditure elasticity from the study were that majority of respondents gave concentrates (dairy meal) to lactating cows only during milking time using fixed quantities of 2kg/milking time in disregard of the nutrition benefits to the lactating cows. The relative low expenditure elasticity for minerals indicated that minerals were considered an inexpensive necessary good by the respondents for growth and development of the dairy cows.

The conclusion based on findings on the decision and willingness to participate in feeds market was found to be influenced by age of the household head. This played an imperative role as a proxy for experience in farming and uptakes of new technologies, however, older farmers tend to be risk averse and prefer practices they are familiar with. Conclusions from observations on the variable for level of education was that it endowed the household with better production and managerial skills which could lead to increased participation in the market for feeds.

On gender, the conclusion was that more males participated in markets for dairy cow feeds than females who contributed more on dairy farm labor. Farm size had a negative influence on the extent of market participation by the respondents and the conclusion was that large farm owners had higher levels of diversification of land use.

5.2 Recommendations

5.2.1 General Recommendations

The study findings acknowledge that dairy farmers are faced with various hindering factors. These negate adoption of strategies on fodder conservation especially for farmers with limiting land sizes. It is of paramount importance that emphasis on enforcing implementation of fodder conservation and management at farm levels by the extension services providers should be taken seriously in sustaining stable milk production.

Alternatively, to address the issue of cow feeds scarcity set up mechanisms to facilitate emergence of fodder marketing co-operatives/ farmer groupings. These can identify large scale farms outside the study area that produce hay, crop husks and maize stovers after harvests and link them to members. They can be able to negotiate contracts to supply fodder at fair prices hence passing on the saving to farmers. Promote forage production as a business through trainings by extension workers on community fodder seed and planting material production at group-led demonstration plots and sell to other farmers.

Recommendation on the effect on feeds by unreliable weather against low prices of outputs (milk and other products), the government/Counties should increase the total expenditure spent on agriculture within the country to propel smallholder dairy development. Offer trainings to farmers on value addition of products, water harvesting measures and use of irrigation systems to grow fodder. Establishment of insurance cover to dairy farmers which is crucial in managing risks related to mortalities due to drought and floods.

5.2.3 Policy Recommendation

To create a seamless availability of dairy feeds, policies should be put in place to ensure promotion of irrigation. Water harvesting techniques, digging of boreholes and water pans will provide water to grow fodder throughout the year.

To promote women participation to feed better their cows, the study recommends flexible bank/co-operatives loan schemes that are favorable to women. Central government should increase the Women fund to reach the rural women. Financial institutions such as banks should increase the threshold of the loan amounts to dairy farmers, government to double the availability of agricultural grants and funding to dairy farmers in Kenya.

The study recommends that Central government together with County governments improve key physical infrastructures to enable farmers reduce transportation costs. However, though work is being done by the current government it is not enough. A one-time push on road sector investments is urgently needed for the establishment and upgrade of road networks for ease in movement of dairy feeds and products.

The study recommends that in order to assist dairy farmers in regard to fluctuating high prices of agricultural based inputs such as concentrate feeds, dairy inputs, and drugs, the Central government needs to revise on legislative and statutory framework through eradication of taxes and levies. The dairy development policies including the Dairy Industry Act all need to be coherently addressed and legislated, and establishment of mandates that align pricing policies in line with legal requirements. Establish proactive dairy boards within Counties and their management by farmers for farmers to enhance and improve the capacity to enforce regulations that deter and penalize the manufacturing of substandard and inferior feed inputs, supplements and concentrates.

5.3 Further research

The main intention of the study was to assess demand of dairy cow feeds and market participation decisions of small-scale farmers in the study area. This was as a dairy cow feeds constraint mitigation measure to improve productivity and incomes hence poverty reduction. However the study came across several dairy production challenges related to feeds and feeding and proposes future research:

To determine the existing feeds resource base in terms of dry matter (DM) available, there is need to comprehensively evaluate potential supply vs. demand for feeds in the study area and in the country. This is taking into consideration the challenge of African agriculture is how to plan to ensure significant improvement on variability in productivity due to effects of climate change.

This is in view of ensuring higher productivity of the dairy animals while reducing poverty levels.

To supplement the current work, a detailed monitoring research is imperative to further investigate detailed daily on-farm monitoring on the current existing dairy practices. These should be on qualitative and quantitative of feed rations provided to cows by the farmer to come up with possible interventions and conclusions.

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APPENDIX I: QUESTIONNAIRES

Hello, my name is Josephine Wandaho Njogu I am a master's student at Egerton University Under taking a research on ''*Assessment of Demand forDairy cow Feeds, Market Participation decison of smal scale farmers in Kiambu County, Kenya*''. The purpose of this study is purely academic and I therefore kindly request you to feel free when answering the questions asked as necessary confidentiality will be maintained. The questionnaire will take about an hour.

Questionare Code…….-

Name of interviewer……

Place of interview…….....

Date……

INSTRUCTIONS

Kindly tick only one option in the questions with alternative answers.

Kindly give brief and precise answers in the blank slots provided in the questionnaire.

Thank you for taking part in this study, the information you provide will be treated with **utmost discretion.**

SECTION A: Background Information

1.1 Gender of the household head……. (*1=Male, 0=female*)

1.2 Age of household head ……..years

1.3 Marital status……... *(1=Married, 2=Single, 3=Widowed,*)

1.4 Household family size (*number of people living and eating together*) …….....

1.5 Household composition

Household Composition	Children (Below 18 years)	2.3 Adult males (18-64yrs)	Adult females (18-64yrs)	Aged (=>65yrs
No. of household members				

1.6 What is the education level of the household head? ..... (*5=Non, 4=primary, 3=secondary, 2=college, 1=university)*

1.7 Household head main occupation……..

(*1=Farmer, 2=Trader, 3=Teacher, 4=Public servant, 5=Laborer, 6=Chop operator, 7=Driver , 8=Others Specify*……)

If employed what is your monthly income in ksh. ……

1.8 What farm produce gave you incomes? …….. (1= sale of milk, cash-crops, cow, food crops, fodder; 2= milk, Napier, manure; 3= milk, other livestock

1.9 Do you have any off-farm income (1=Yes; 0=No)

2.0 If Yes (above) what is the estimate amount received from off farm activity? ……

SECTION B: Farm Characteristics and Extension services

2.1 What is the total size of land owned by the household? ..... Acres

2.2 What is the type of land tenure for this parcel of land? ..……*(1=individual, 2=Leasehold, 3=communal)*

2.3 Do you hire people to work on your farm? …….. (*1=yes, 0=No*)

2.4 If yes, how much do you pay per day per person in Kenya shillings? .....

SECTION C: Household Dairy cows Ownership

3.1 Does the household own Dairy cows? ….. (*1=Yes, 2=No*)

3.2 If yes, indicate the type of dairy cows owned

Type of Cows owned	Number of cows the household currently Own	Total value of cows owned	Number of cows sold in the last 12months	Total amount received from selling dairy cows
1.Grade/Exotic Cows " Calves " Bulls				
2. Crosses				
3.Localcows(indigenous				
TOTAL				

3.3 Household income sources

Income sources for the household in the last 6 months?

Type of earning	Please tick	What is the proportion of total income (%)
Income from farm production (crop produce, forest products)		
Employment (Off-farm income)		
Income from business		
Income from sale of livestock and livestock products		
Income from sale of milk		
Remittances received from relatives, sons, daughters.		
Rented out land/buildings		
Other structures rented out		
Other source of income specify		

SECTION D: Feed Availability, Shortage, and Market participation decision

i) Feed Resources

4.1 Do you produce own farm (fodder) Napier/grasses/legumes? ..... (*1=Yes, 0=No*)

4.2 If yes, how many acres ---------

4.3 What is the yield per acre? (1=Napier……; 2=Hay……. ; 3=Legumes…..; 4=Others…)

4.4 Do you Practice improved forage production on your farm? ... (*1=Yes, 0=No*)

4.5 If yes, fill the table

Species	Names of forages	Area	Strategies of development	If bought price/unit	No. purchased	Total expenditure
Grasses						
Legumes						
Napier						
Fodder tree						

Strategies of development; (*1= over sowing/reseeding on private/communal grazing; 2=under sowing; 3=planting tree legumes as fence 4= planting as pure stand*)

4.6 Do you consider feed quality when selecting the crops you grow in relation to cow feeds? ..... (*1=Yes, 0=No*)

4.7 What indicators do you use to assess feed quality? ... (*1=Palatability 2=Color 3=More leafy 4=Smell 5=Texture 6=Others (specify)* ----------)

4.9 What are the consequences of low quality feeding of your animals? ..... (1=reduced milk yields; 2= reduced growth rate; 3= frequent abortions)

ii) Feed Constraints

4.10 Were there any months when there was feed shortage for the cows? ….. (*1=Yes, 0=No*)

4.11 If yes, what cow feeds often run out of stock? …… (1= Napier; 2=Hay; 3= Others)

4.12 Please rank on a scale of 1-2 feed availability on the last 12 months from own production? (where *1=little feed available* and 2= *excess feed available*)

Months	Jul 2014	Jun 2014	May 2014	April 2014	March 2014	Feb 2014	Jan 2014	Dec 2013	Nov 2013
Feed Availability									
Score 1-2									

4.13 What were the consequences of feed shortage on your cows? ..... (*1= Weight loss*

2=Milk yield reduction 3= Increased mortality 4=Abortion frequency 5= Weakness 6=Others, specify----------)

4.13 What were the measures that you took to alleviate consequences of feed shortages? …. (*1=Feed preservation as hay 2=Use of improved forage production 3=Purchase concentrates. 4=Forage purchase (rent grazing land) 5=Destocking. 6=No measures taken 7=Others (specify)….*)

4.14 What determines what to feed the cows? …. (1= Breed, lactating stage; 2=Age, lactating stage;3= Others (specify))

iii) Feed conservation & formulation Practices

4.15 Do you conserve or formulate any cows feed? … (1=Yes; 0=No)

4.16 If no to conservation give reason …… (1=Small land size; 2= lack knowhow; 3=lack of materials)

4.17 If no/yes to feed formulation, what are the contributing factors towards the decision (rank 1-2, where 1= most important constraint and 2 = least important constraint)

Constraint/factor	Rank
Lacks knowhow	
High cost of feeds	
To reduce cost of feeds	
To improve feed quality	

4.18 Which Constraints /Parameters highly affect availability of cow feeds in your area (rank 1-2, where 1= most important constraint and 2 = least important constraint)

Constraints	**Rank**	**Remark**
Shortage of rainfall		
Livestock population pressure		
Shortage of grazing land		
High cost of feeds		
Land degradation and low biomass yields		

Low quality and variability of feed across seasons		
Water logging on grazing land		
Lack of extension services		
Lack of high quality forage seeds		

iv) Market Participation decision

4.19 How would you rate the future of dairy enterprise in your county? (*1=Very Promising, 2= average, 3=Poor*)

4.20 Do you participate in markets to purchase feeds for the cows? … (*1=Yes, 0=No,*)

4.21 If yes, do you participate as a buyer or seller? … (*1=Buyer, 2=Seller, 3=Both*)

4.22 What informs your decision to participate in the market? … (*1= Excess production, 2= Scarcity, 3=Price of outputs,*)

4.23 Which cow feeds do you produce/grow for sale in the market? … (*1= Napier, Hay legumes; 2=Concentrates; 3= Others (specify)……..)*

4.24 How many (sacks) of cow feed do you sell in the market per month? …. (1=<50; 2=>100; 3= over 300)

4.25 Do you buy feed supplements for your cows? ..... (Yes= 1, 0= No)

4.26 If yes which supplements? ..... (1=pineapple pulp, 2=Brewers waste, 3=Dairy meal, 4= Others (specify)…….)

4.27 What determines your decision to buy a certain supplement? ..... (1= Prices, 2=Policies, 3=Extension service providers, 4=Neighbors, 5= Others (specify)……..)

4.28 Which is your source for supplement feeds? … (*1= Other farmers, 2= Stockists, 3=Transporters, 4= Co-operative*)

4.29 What is the Price unit (70kg) of dairy meal? .....

4.30 How much on average do you spent on dairy meal per month ……...

4.31 What is your average monthly expenditure on pineapple waste …….

4.32 What is the Price per unit (pickup) of brewers waste ……..

4.33 What is your average monthly expenditure on brewers waste …….

4.34 Price per unit (liter) of wet yeast …….

4.35 What is your average monthly expenditure on wet yeast ……

4.36 What is the Price unit (kg) minerals …….

4.37 How much on average do you spent on minerals per month ……..

4.39 What is the cumulative expenditure on grain feeds, minerals and by-products per month …..

4.40 Do you formulate own feeds? …. (1=Yes; 0=No)

4.41 If no/yes what is your reason

……

4.42 Which months do you highly depend on markets for dairy cow feeds? … (*1=Jan-March, 2=Apr-June, 3=Jul-Sept, 4=Oct-Dec*)

4.43 How far is your farm to the nearest market (km)? ……

4.44 Does distance affect your participation in the market? … (*1= Yes, 2= No)*)

SECTION E: Institutional Support and Extension Services

5.1 Did you receive any extension service? ..... (*1=yes, 0=No*)

5.2 If yes above, how often have you had contact? ..... (*1= Very often, 2=Often, 3=Least often*)

5.3 From where did you receive the extension services? ..... (*1=Government officers, 2=Soceity,3= Private)*

5.4 Is there any cost you have paid for any extension service? .... (*1=yes, 0=No*)

5.5 If yes, how much did you pay for the service? .....

5.6 Do you belong to any farmer groups or co-operatives? ..... (*1=Yes, 0=No*)

5.7 If yes, specify the name …….

5.8 How long have you been in this group?_____

5.9 What are the role of your group?_____

5.10 Are there any benefits that you get being a member of this group? …… (*1=Yes, 0=No*)

5.11 If yes, which ones? …… (*1=Advice/Education on farming practices, 2=Easy access to farm inputs, 3=Easy access to capital and loans, 4=Easy access to farm implements, 5=Transportation services and access to ready markets, 6= others please specify*……)

5.12 Did you receive any credit? …… (1=Yes; 0=No

5.13 Type of credit accessed ……. (1= cash credit; 2= In-kind credit)

5.14 Amount of credit received (ksh) ……

5.15 Where did you receive credit from …… (1=society; 2=Bank;
3 = Others (specify) …….