ADOPTION OF MODERN DAIRY TECHNOLOGIES AND ITS IMPACT ON MILK PRODUCTION IN NZAUI SUB-COUNTY, MAKUENI COUNTY

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DECLARATION

I understand that plagiarism is an offence and I therefore declare that this thesis is my original work and has not been presented to any other institution for any ward.

Sign …………………………… Date ………………………….

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DEDICATION

I dedicate this thesis to my family members for their love, support, patience, encouragement and understanding. They gave me the will and determination to complete my research and thesis preparation.

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ACRONYMS AND ABBREVIATIONS

A.I. Artificial Insemination

AEZ Agro Ecological Zone

CAIS Central Artificial Insemination Station

DLPO District livestock production officer

EADD East Africa Dairy Development

ET Embryo Transfer

FAO Food and Agricultural Organization of United Nations

GOK Government of Kenya

GDP Gross Domestic Product

KCC Kenya Cooperatives Creameries

KDB Kenya Dairy Board

Ksh Kenya Shillings

LH Lower Highland

SDCP Smallholder Dairy Commercialization Program

SPSS Statistical procedure for social science

SSA Sub Saharan Africa

SSMVs Small-scale milk vendors

UH Upper highland

UM Upper Midland

UNDP- United Nations Development Programme

ABSTRACT

Dairy production is a biologically efficient system that converts large quantities of roughage in the tropics to milk. Milk production levels are determined by the levels of technologies applied to the dairy enterprise. However, information on levels of adoption of dairy technologies especially in the arid and semi-arid areas (ASALs) of Kenya is scanty. This study thus sought to evaluate the extent of adoption of modern dairy technologies and its impact on milk production in Nzaui Sub-County of Makueni County which is one of the ASAL counties in the country. A cross-sectional descriptive survey design involving the use of questionnaires was used to collect relevant data from a total of 306 livestock keeping households in Kawala, Ndovea and Matiliku sublocations. Data was analyzed using descriptive statistics and logit regression estimations with the help of SPSS econometric software. The study showed that the adoption of improved dairy technologies was low, about 13% across the study sites. Over 96% of the farmers' conserved livestock feeds, while 63% of the farmers used animal supplementation technologies. Factors which influenced farmer rearing of improved animal types included gender, marital status, and income levels. For fodder conservation technologies, the most important factors included marital status, training, and extension services. The adoption of animal supplementation was influenced to a great extent by income levels and occupation rather than household endogenic factors. In regards to milk yield, farmers with larger farm sizes, more incomes and training access were better placed to achieve high milk yields than those with lesser of those characteristics. It was concluded that there is need for gender-specific interventions to enhance increased adoption of improved livestock technologies by farmers especially in regards to access to improved germplasm by all farmers. Access to improved dairy cattle is the first step to enhancing milk yield, followed by other interventions. Other areas of interventions include enhanced access to technologies that promote fodder production and promotion of access to credit facilities for acquisition of dairy breeds.

Key words: Constraints; fodder; interventions; socio economics; technologies; training;

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Dairy production is a biologically efficient system that converts large quantities of roughage, the most abundant feed in the tropics to milk which the most nutritious food known to man. In areas where there is access to markets, dairy production is preferred to meat production because it utilizes feed resources more efficiently and provides a regular income to the producer (Walshe *et al*., 1991). Dairy production is labour intensive and supports substantial employment in production, processing and marketing. In order to achieve higher levels of production than those in traditional tropical systems in cattle, it often requires introduction of pure or improved dairy breeds and increased levels of inputs in form of nutrition and health care. It equally requires good linkage to markets for inputs acquisition and milk sales. Thus, the intensification of smallholder livestock systems through the adoption of dairy production is generally concentrated in areas with good infrastructure and close to major markets. Less intensive dairy production may also occur in other areas away from the major urban centres (Walshe *et al*., 1991). These market factors play a major role in determining the type of dairy production systems found in the tropics, and they are particularly important influences on smallholder dairy development.

In developing countries where large population lives in rural areas, improved dairy production can provide employment opportunities to the youth and women thus improving household level food security, reduce rural urban migration and increase of national income. Therefore, investment in the dairy sector creates more job opportunities as it is labour intensive and alleviates poverty than other agricultural sectors. It is particularly significant in addressing many challenges faced by youth and women in rural areas.

Dairy industry in Kenya was first introduced by the European settlers in the white highland at the beginning of 20^{th} century and the Africans were not allowed to keep the dairy animals until late 1950s when the colonial policy paper Swynnerston Plan of 1954 was introduced, which allowed the African to engage in commercial agriculture (FAO, 2011). Exotic breeds were mainly imported from Europe and were placed in wet and cool temperate climate areas which were similar to the one they came from in Europe. These areas were close to the urban areas for ease of marketing the milk.

The new settlers and the colonial government initiated various measures to support this by establishing veterinary research laboratory at Kabete near Nairobi and Animal Husbandry Research Station at Naivasha in 1902.These facilities were to assist in animal disease control and research. For the purposes of processing milk from these animals, Kenya cooperatives creameries (KCC) was started in 1924 and by 1946, Central Artificial Insemination Station (CAIS) was established to control reproductive diseases and produce of high quality semen (Conelly,1998). After independence most of these large dairy farms owned by European settlers were bought, subdivided, and issued to landless African Kenyans together with these exotic animals, thus the start of the smallholder dairy farmers (Thorpe *et al.,* 2000).

Over 80% of the total marketed milk in Kenya is contributed by smallholder dairy farmers and the sector contributes up to the 4 % GDP in the country. According to ACET (2015), the country has more than 1.8 million smallholder dairy farmers and the dairy sector generating an estimated 1.2 million persons in direct and indirect job opportunities.

Therefore, any slight improvement of dairy productivity could create more jobs opportunities in rural areas. This effect could be more pronounced in the transition zone (Upper Midland -UM) with annual rainfall of between 750 to1000mm, where land holding sizes are more than in the traditional dairy areas of Upper Highland (UH) and lower Highland (LH) Agro ecological zones (AEZ) with annual rainfall of over 1000mm. Improvement of dairy in UH and LH, is limited by small land holding sizes due intergenerational land subdivisions and therefore land kept aside for fodder cultivation has been reducing with time.

There is potential for dairy development in the UM zones in Kenya where most the small dairy farmers are found, as land holding sizes are larger and therefore land kept aside for fodder cultivation is higher. With improved strategies of fodder production, fodder conservation, vaccination, concentrate feeding, deworming and improved breeding intensification and commercialization of dairy production can be intensified (Staal, 2002), leading to more employment in the rural areas.

High milk production can be achieved by adopting and implementing sound dairy technologies which have been developed by research institutions and universities. However, these new dairy technologies are not being used by many dairy farmers. Various research findings indicate that many dairy farmers rely on traditional animal husbandry strategies which result in low milk yield (Letha, 2013). According to Ahmed *et al.,* (2004), this low production could be attributed presence of large number of small scale dairy farmers who do not use the improved technologies and who dairy production is only a secondary enterprise.

Dairy enterprise production is largely dependent on the farmers' behavior uptake of modern dairy technologies as well as their socioeconomic characteristics status (Wekesa *et.al.* 2003). These status includes training levels on dairy husbandry, experience on dairy husbandry, exposure to information on dairy husbandry, contact with extension agents, knowledge on improved dairy technologies and education levels.

Increase in productivity in dairy animals is constrained by inadequate feeds, losses from livestock diseases, inadequate access to inputs and extension services in most of Eastern and Southern Africa (Muriuki and Thorpe, 2004).

Adoption of improved breeds, modern breeding systems, use of concentrates, fodder production, and fodder conservation methods were the technologies which were studied, The current research was designed to access the adoption levels of these modern dairy technologies and its impact on milk yield, how socioeconomic aspects of households affect adoption and the constraints limiting adoption of the modern dairy technologies among smallholder dairy farmers in Nzaui Sub-County, Makueni County

1.2 Problem Statement and Justification

Nzaui Sub-County has poor dairy development despite its potential attributed to favorable agro climatic conditions and ready markets for milk and milk products. In the study area, there is high demand for milk and milk products than the supply from within and hence the SubCounty depends on milk supply from other SubCounties (MALD**,** 2008). Rapid urbanization as a SubCounty headquarters, increased population and increase income have created increase demand of milk and milk products. Therefore increased dairy development through adoption of modern dairy technologies in the area would provide employment opportunities to the rural youth and women, reduce rural urban migration and improve nutritional condition of the children through increased milk consumption.

The study was being conducted to assess level of adoption of modern dairy technologies among dairy farmers, their constraints and how social economic characteristics of farmers affects their adoption in Nzaui Sub-County of Makueni County. The results will be used by policy makers, researchers and extension agents involved in development of extension packages for livestock farmers in the area. Similar studies but with different technologies have been done in agro ecological zone (AEZ) upper highlands and low highlands which have been known to be dairy areas for a long time. Much of studies on dairy technologies adoption have been done in Kenyan highlands, coastal lowlands and western Kenya (Baltenweck, 2010). However, there is no information on adoption of modern dairy technologies in the study area.

1.3 Objective of the Study

1.3.1 General Objective

To evaluate the extent of adoption of modern dairy technologies and its impact on milk production in Nzaui Sub-County of Makueni County

1.3.2 Specific Objectives

i. To determine the adoption levels of selected dairy technologies and their effects on milk products in Nzaui Sub-County
ii. To determine the effects of social economic characteristics of farmers on the level of adoption of modern dairy technologies in Nzaui Sub-County
iii. To determine the constraints affecting the adoption of modern dairy technologies.

1.4 Research Questions

i. What are the levels of adoption of modern dairy technologies at Nzaui Sub-County?
ii. How do the social economic characteristics of farmers affect the level of adoption of modern dairy technologies in Nzaui Sub-County?
iii. What constraints affect the adoption of modern dairy technologies at Nzaui Sub-County?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Dairy Production in Kenya

Kenya has one of largest dairy sector in the sub Saharan Africa based mostly on smallholder milk production. It has the largest population of exotic breeds and their crosses in East and Southern Africa (Doss, 2006). This high adoption of exotic breeds in Kenya has been attributed to the favourable production environment (mid to high altitude with bimodal rainfall patterns) and the importance of milk in the diets of most of the rural communities and urban dwellers in this region (Chipande, 1987). Majority of the rural systems producing marketed milk in Eastern and Southern Africa are integrated crop–dairy systems, which benefit from the positive association between the dairy enterprise, staple food crops (generally maize) and cash cropping (Staal, 2002).

Thorpe and Muriuki (2004) noted that Kenya has about 2.7 million improved cattle which accounts for about 75% of all the improved cattle in Eastern and Southern Africa and this contributed about 20% of the total 7.5 million tonnes of milk produced in sub Saharan Africa in 2003. A dairy cow in Kenya has an estimated milk yield of 1500 litres per lactation while indigenous cattle has milk yield of 250 litres per lactation (FAO, 2011). Over 80% of the total milk production in Kenya is found in the former Rift valley and Central provinces where most of the dairy animal are found (FAO, 2011).

2.1.1 Dairy Production in Semi -Arid Areas of Kenya

Dairy farming is ranked the third most important agricultural enterprise in the semi-arid region of eastern Kenya (Itabari *et al*., 2006). Urbanization, increased in population and increased incomes have stimulated the growth of dairy industry in the region due to the demand for milk and milk products (Njarui *et al.,* 2010). However, inadequate adoption of dairy technologies is major constraint that impact negatively on the growth and viability of the dairy farming in the region (Njarui *et al*., 2009). Inability to provide sufficient quantity and quality of feed to livestock is widespread in East Africa (Njarui *et al.*, 2011) and the same has been reported in coastal lowlands of Kenya (Reynolds *et al.*, 1993).

In Kenya, majority of smallholder farmers keep more animals than they can feed from their own land, leading to sub optimum productivity. Estimate by Reynolds *et al.*, (1996) in 1990s showed that smallholder dairy farmers produced about 70% of the feed required from their own resources and this situation has remained relatively the same. Over 80% of farmers in the semi-arid region of eastern Kenya are smallholder (Njarui and Mureithi, 2006) that practice mixed crop-livestock subsistence farming. Most of the fertile land is allocated for food crop and cash crop production leaving very limited and less fertile land for pasture production with no or little inorganic fertilizer or manure application (Njarui and Mureithi, 2006).

The scarcity of feed is exacerbated by low and erratic rainfall of 500-800mm per year leading to long dry season and frequent droughts. This results in cessation of growth of pastures and consequently limiting fodder production. The quality also declines significantly during the dry season and is insufficient to meet animal production potential (Thairu and Tessema, 1987). Maintaining access to adequate quantity and quality of feed resource is crucial for milk production and reproduction in dairy cattle. Ability of the farmers themselves to utilize this low and erratic rainfall to the maximum by cultivating fast growing forage crop and grasses for storage as hay that can meet the animal feed requirement during the duration feed of stress associated with long dry period and frequent droughts is low.

As Lwelamira *et al.*, (2010) observed in dairy production systems analysis, reduction or cessation of milk production to already low producers and loss of live body weight is experienced in dairy animals with low genetic potential but their health and fertility is maintained when provided with inadequate feed. While for dairy animal with high genetic potential, the same proportion reduction of feed will result in reduced milk production, marked loss of live body weight, poor health and loss of fertility. Therefore, availability and adequate supply of high quality feed to a dairy animal is essential for optimum production and reproduction (Lukuyu *et al.*, 2007). Unfortunately, inadequate and low-quality feed are main features among dairy production systems in upper midland agro ecological zones. This situation is exacerbated during the prolonged dry and drought period which is quite common in these zones, where majority of smallholder dairy farmers are found in Kenya (Mwangi and Wambugu, 2003). Dairy animals feed shortage in these zones can be addressed through development of appropriate farmer friendly and sustainable technologies in forage production and conservation. In addition, treatment of low quality crop by-products and residue can improve their quality (Eyob,2017**).** Appropriate methods can be devised on how to transfer these technologies to farmers while taking into account their physical, social,financial and knowledge limitation as well as their climatic conditions (Lwelamira,*et.al*.,2010). Labour in smallholder dairy in developing countries is mainly provided by family members and since it is not the main enterprise, women form the bulk of this labour force as men are engaged in wage employment in urban areas (FAO, 2011).

2.2 Technology Adoption

In general, adoption may be viewed as an act of accepting or approval, accepting or choosing or taking something as your own. Rogers (1995) defines adoption of an innovation as the mental process of decision making that begins with hearing about the innovation to its final adoption. Five stages of the adoption process include knowledge, persuasion, decision, implementation and confirmation (Rogers, 1995). Initial adoption is generally followed by diffusion and spread of the technology within a region.

According to Rogers (1995) adopters can be classified into innovators, early adopters, early majority, late majority and laggards based on the adoption decisions they make. Massey *et.al.*, (2004) extensively reviewed the literature regarding early adopters, suggesting that adoption will happen quickly if the individual is better educated, receptive to new ideas, self-confident and younger, and the farm system is large, profitable, endowed with absorptive capacity, able to transplant information, and linked with other farms and networks (Liu, 2002).

Studies done on farmers' adoption choices in relation to their social network by Bandiara and Rasul (2006), found that there is positive social effect if adopters were few in a network, however, this effect is negative with many adopters. According to Abdulai and Huffman (2005), the effects of diffusion of cross-bred cows among farmers are stronger for smaller than large areas in Tanzania, and that adoption was positively correlated with Credit availability and contact with extension agents. However, in the context of Mozambique, Bandiara and Rasul (2006) wrote, "Providing more incentives to adapt early to a large group of farmers can actually reduce the incentives to adopt for other farmers around them".

In Tanzania, Abdulai *et.al. (*2008) studied the decision of dairy farmers to acquire information and adopt technology in the presence of uncertainty. They found that human capital and scale of operation were positive and significant in the adoption decision. Increases in education, age and herd size, and an expectation of higher profitability from the technology were found to have positive effects on adoption intensity.

2.2.1 Adoption of Dairy Technologies and Milk Production

Productivity refers to the amount of output that can be produced from a given unit of input (Rao, 1993). In terms of milk production, productivity improvement entails increasing the amount of milk output per unit of inputs. Such productivity improvements are often associated with technical change (or use of improved technologies). Technology refers to mechanism/process of using inputs to produce output and to the extent that such processes reduce the amount of inputs needed to produce the given unit of output, such a technology would be deemed to enhance productivity. Besides technology, productivity improvement can also result from efficiency with which technologies are used (Nkamleu, *et al*., 2010).

Increasing agricultural productivity among small holders in developing countries will depends on the levels adoption of new technologies and innovations. Adaptation requires local learning and modifying general scientific principles and technologies to fit specific contexts. This new approach has been recognized as the method of poverty reduction and human development in developing countries (World Bank, 2008). Agricultural production has remained low in the sub Saharan Africa (SSA) than other regions due to low adoption of technologies (UNDP, 2012).

2.2.2 Technologies for dairy cattle breeding

Animal breeding programs in Kenya have largely aimed at improving dairy productivity, shortening calving intervals and enhancing herd fertility among other goals (Rege *et. al* ., 2001). There is no explicit breeding policy in Kenya but there are various generic policy statements guide breeding programs in the country (Staal and Kaguongo 2003). Generally, the policy statements aim at increasing dairy productivity through breeding and selection implemented via wider use of artificial insemination (AI) and bull camps. A further goal is the production of high-yielding and diseases resistant cattle types. The objective is therefore not to eliminate the indigenous gene but to integrate exotic gene to improve productivity while retaining the disease breeds resistance and local adaptability traits of the indigenous gene.

Main institutions in dairy cattle breeding include Kenya Stud Book – keeping animal breeding records; Dairy Recording Service – to keep milk performance data; Kenya Animal Genetic Resource Centre – to produce and distribute semen (FAO, 2011)

In order to achieve the goals of the breeding policies, there are various dairy breeding technologies and interventions which the country has introduced over the years.

Artificial insemination: One animal breeding technology that has widely been promoted by government is artificial insemination (AI). Until the mid-1980s, there was a well-organized dairy cattle breeding system subsidized by the government that contributed to growth of the smallholder dairy farming system (FAO, 2011). Consequently, AI was used effectively to accelerate uptake of dairy farming by upgrading the local zebus. However, led to reduced government involvement in breeding activities. There has seen a gradual replacement of government AI provision by private players, albeit at a slower rate.

Nevertheless, private AI services remain quite underdeveloped and this together with the perceived high cost of the service, has led to frequent use of bulls of unknown breeding value across the country (Okeyo *et al*., 2009).

In spite of many years of research and extension efforts, agricultural technologies adoption by farmers has been very low and especially those dealing with livestock. For instance, even though smallholder dairy project was implemented in Kenya from 1997 to 2005, the uptake of the technologies by dairy farmers has been low **(**FAO, 2011). Therefore, milk production per cow per year has stagnated within Sub Saharan Africa (Muriuki and Thorpe, 2001).

Gender selected/sexed semen. This is virtually an AI technology that is gender biased towards heifer. Using this technique, farmers can be about 90% certain of the gender of their calves. From a dairy perspective, the technology presents substantial opportunity for increasing population of heifers, which would address the biting shortage of heifers and translate to increased milk production. The other advantage is that it presents opportunities in accelerated upgrading process**. (**Thomin, 2016)

Embryo transfer (ET*)*. The use of embryo transfer has remained at a low level overall but is common in those stud herds where breeding bulls are produced, particularly those that sell to AI centres (Betteridge., 2003). It has also provided a method for importing genes from overseas while keeping down transport costs. Generally, ET is less expensive than live animal importations but it is wholly dependent on the number of calves born per 100 embryos implanted. ET is normally too expensive for breeding commercial dairy cows (Ngila, 2011).

2.2.3 Feed technologies/interventions

Dairy production systems can broadly be divided into two categories: large-scale and small-scale. The categorization is based on scale of operation, level of management and use of inputs (Mukolwe *et al*., 1990). Most dairy animals in semi-intensive and extensive production systems in Kenya are kept under an open grazing system with supplementary feeds provided occasionally. It is only in densely populated regions where intensive systems characterized by zero grazing and stall feeding are more prevalent (Jackline, 2002).

The main sources of feed for smallholding systems include forage, cultivated fodder and crop by-products. Of the cultivated fodder, Napier grass is by far the most commonly used source. Other common feeds and forages include maize stovers, dried poultry waste, hay (purchased pure Lucerne, grass or Lucerne/grass mix), silage (by a few farmers), home-made rations of locally available grains and other ingredients, and grazing, which is the most common source of animal feed (FAO, 2011). There is some limited use of commercial feeds such as dairy meal, dairy cubes, calf pellets, maize germ, maize bran, molasses, cottonseed cake, and wheat pollard and wheat bran among others. Commercial feeds have however, witnessed dramatic price increases in the aftermath of the post-election crisis and the world economic downturn in 2008 (FAO, 2011). Moreover, most commercial feeds are characterized by poor feed quality.

Overall, feeds account for the largest share of the cost of milk production in market oriented dairy farming in Kenya (Ndegwa *et al.*, 1999). Indeed, many farmers practicing either system of production are often faced with feed insufficiency, particularly in the dry season. This has necessitated development and dissemination of feed technologies and interventions in order to increase feed availability at farm level (Hall, 2007).

Planted fodder, herbaceous legumes, improved grasses, fodder trees and shrubs

The major feed for livestock in the country for the smallholder dairy farmers are natural pastures and planted fodder, mainly Napier grass (*Penisetun purpureum*), (Ouma *et.al.*,2000). Various fodder legumes and fodder trees and shrubs have also been introduced to farmers with varying successes as a means of increasing milk production. Of significant success is *Calliandra haematocephala* that has particularly been widely and rapidly adopted by many dairy farmers in Kenya as a protein supplement for their cows (Franzel and Wambugu, 2007). The ease with which it fits into the existing farming systems made it easily adoptable by dairy farmers across the country. Other fodder legumes introduced so far include Desmodium while other protein-based grasses such as Rhodes grass and Columbus grass are also being promoted in various regions of the country.

Improved dual purpose crops and crop residues

This involves the use of fodder from crops during the growth cycle such as leaf strips, sheath, toppings, thinning, and sweet potato vines. Some farms also use crop residues, some of which is micro-processed to improve on their storability (Hemme *et al*., 2004). The most common crop residue includes maize stover and wheat straw. Given the need to improve storability of feeds for use in dry seasons, the promotion of these crop residues has often been accompanied by promotion of processing technologies (EADD, 2011).

Feed processing technologies

To improve utilization of the crop residues and other fodders, farmers also process feeds using various technologies. The most common processing technology which is increasingly becoming popular is the pulveriser technology (Letha, 2013). Some farmers also treat their feeds chemically using urea/ammonia while some also do biological treatment (Lwelamira,*et.al.,* 2010). Chemical and biological treatment have, however, not been widely adopted because they demand technical knowledge and are quite costly to implement. There are also isolated cases where farmers are storing unprocessed crop residues such as maize Stover and bean husks. Indeed, increased feed conservation and utilization of crop residues has been realized due to the wider adoption of the feed processing equipment, mainly the pulveriser and grass cutter promoted by EADD program (EADD, 2010). About 480 pulverisers have been purchased by farmers across EADD sites.

Feed Conservation technologies

Besides planted fodder, legumes and shrubs, feed conservation technologies have also been introduced to smallholder dairy farmers in the country to address feed scarcity that is usually more evident during the dry seasons. The most common conservation methods that have been introduced to farmers are hay and silages, which apparently have been adopted on a very limited scale (Njwe, 1984). Hay is usually preserved either as standing hay or it can also be machine- or box-bailed. Various types of silos exist such as polythene/tube silos, plastic tank silos, above ground silos and trench silos.

2.2.4 Milk marketing and handling technologies/intervention

The milk marketing system in Kenya can be divided into two sub-systems, formal and "informal". The formal milk market is made up of about 30 licensed milk processors – two of which – KCC and Brookside, account for about 60% of total processed milk. Processors in total handle about 80% of total milk and dairy products marketed through the formal market channels. Other licensed milk traders include producers, mini dairies, cottage and cooling plants whose numbers have been increasing (Mwangi *et.al.* 2000). Cooperatives are the main channels for collecting milk destined for the formal markets composed mainly of milk processors (Owango *et al*., 1998).

The informal sector accounts for the largest share of over 80% milk sold. This growth is mainly supported by the inefficiency of the formal marketing system, consumer habits/preference as well as price difference between raw and processed milk. Consumers are indeed major players as they influence how other players perform. In spite of regulatory regime prohibiting sale of raw milk, consumer demand has resulted in less than 20% of marketed milk being processed (Omore *et al*., 1999).

Apart from farmers supplying cooperatives, most farmers tend to sell their milk individually and this exposes them to manipulative practices by some milk traders (Jaetzold *et al.*, 2006). Furthermore, pricing analyses reveal that consumer prices have continued to skyrocket over time while producer prices and their share of consumer prices have declined. This has tended to discourage farmers from improving their level of productivity (Jaetzold *et a*l., 2006). To address some of these limitations various technologies and/or interventions for milk handling and marketing have been designed including Chilling plants, Ideal aluminium milk containers, Mastivac, Collective marketing, the hub approach, training and certification of SmallScale Milk Vendors (SSMVs).

Chilling plants

This is a technology that is targeted at rural based smallholder dairy farmers who are faced with the challenge of milk spoilage and spillage occasioned by long hours of transport on dilapidated roads. The chilling plants were established to serve as milk collection points linking producers to formal markets. Several dairy farmers' cooperative societies operate chilling plants even though quite a number of them are operating below capacity. Some have also collapsed due to mismanagement and leadership wrangles that have been the hallmark of the cooperative movement in Kenya. However, renewed efforts under various programs such as the East Africa Dairy Development (EADD) and Smallholder Dairy Commercialization Program (SDCP) revived some of the chilling plants and supported construction of new ones (EADD 2011,).

Ideal aluminium milk containers

Most marketed milk sold by SmallScale Milk Vendors (SSMVs) is transported in non-food- grade plastic containers which are difficulty to clean using bicycles or public service vehicles. This mode of transport and the containers used present crucial challenges in terms of milk quality and safety (Kurwijila, 2006). To address this challenge, the Smallholder Dairy Project developed an "ideal aluminium milk container" suitable for SSMVs. The container is designed to allow for easy transport and to avoid spillage and contamination of milk during transit. However, uptake of this technology has been quite slow with just under 10% of SSMVs using the containers (Patel, 2001). The low uptake is partly because the containers are expensive for most SSMVs. The containers are also not suitable for other modes of transport, other than the bicycles for which they were designed.

Mastivac

Kenya Dairy Development Program (KDDP) together with World Wide Sires (WWS) in collaboration with Nairobi Veterinary Centre, a private sector player, has introduced *Mastivac,* a vaccine for controlling mastitis in dairy cattle. *Mastivac* gives full protection against all the bacteria that cause mastitis in cows. The technology is convenient and affordable and results in increased production of quality milk (Kajaysri *et al.*, 2014).

Collective marketing and the hub approach

This collective marketing approach is meant to enhance market access for smallholder dairy farmers who individually may not have sufficient volumes to attract the interest of processors (Kruse, 2012). To avoid the problems of under capacity operation that was evident in several chilling plants, EADD came up with a model aimed at increasing volumes that would profitably sustain the chilling plants. The idea was a hub approach with several productivities enhancing services bundled around the business of the chilling plants. Such services include provision of AI services for upgrading stocks, dedicated extension service for training farmers on feed interventions, animal husbandry practices and animal healthcare services among others (Kruse, 2012).

Moreover, EADD uses a financing model that members own the chilling plant and therefore have a great stake in its survival. Farmers raise 10% of the $125,000 start-up capital to cultivate ownership and accountability, while EADD extends a 30% interest free loan redeemed over 5 years by the chilling plant shareholders through a minimal levy on every litre of milk sold (EADD, 2011). The balance is covered by commercial debts.

Training and certification of Small-scale Milk Vendors (SSMVs*):*

Milk produced by farmers in Kenya is marketed mainly through two channels namely: the private milk processor selling pasteurized and packaged milk products and the Small-scale milk vendors (SSMVs) selling raw milk. Until the year 2004, the SSMVs (hawkers) were unlicensed and were therefore operating illegally. However, policy interventions in 2004 allowed for the licensing of SSMVs to enable them to operate legally **(**KDB. 2005-2009). As part of the licensing process, the SSMVs are required to undergo training on milk handling and hygiene, which is delivered by accredited business development service providers or milk traders association. This has given opportunity for an estimated 44,000 SSMVs to scale up their businesses, which can now be inspected for compliance with milk quality standards (KDB, 2005-2009**).** The policy changes have led to significant reduction in transaction costs and substantial increase in volumes of marketed milk, both of which have had positive economic benefit for the country (Massey *et.al.* 2004).

2.3 Constraints to the Adoption of Modern Dairy Technologies

Improved technology plays a major role in dairy production because it is applicable anywhere as long as traditional constraints are abated (Njarui *et al*., 2009). Therefore, with improved techniques in feeding, breeding and animal health, milk productivity is likely to be a major determinant for income generation among smallholder farmers. According to Njoka-Njiru *et al.,* (2006), what farmers gain from new agricultural technology has a positive effect on the poor households by raising their income while indirectly raising employment and wage rates on landless labourers. This ultimately lowers the price of food staples as the producers of the food are also the consumers.

Dairy production in Kenya experiences numerous challenges that have tended to discourage and hinder the growth of this sector. These include the small-size of most dairy enterprises that limit capacity of the farmers to take advantage of economies of scale. Secondly, there is a general scarcity of well-skilled personnel across the whole value chain. As a result, there is limited and inadequate access to extension, breeding/AI services, and veterinary services among others by the dairy farmers (Nambiro *et al*., 2010). Indeed, extension to farmer ratio is quite low and budgetary provision for public extension services has also dwindled over the years while private extension has not expanded to fill the ensuing gap created by the decline in public extension. In few cases where private extension services exist, the costs are usually prohibitively high. Additionally, inadequate access to breeding services is aggravated by poor infrastructure leading to non-use of better breeding technologies and hence widespread use of bulls with unknown breeding value (FAO, 2011).

Poor physical infrastructure also presents major challenges to milk marketing since most of the produced milk cannot reach the targeted markets during wet seasons when most rural roads are impassable. Furthermore, failure by farmers to adopt appropriate collective approaches has led to inefficient market system leading to substantial losses to farmers (EADD, 2011). Dairy cooperatives that previously contributed to development of smallholder milk marketing and provision of inputs and services at low costs have actually lost out due to many factors: competition, inability to adapt to change, poor payouts, poor management and corruption among others.

Constraints to increased productivity in current dairy production systems include: inadequate year-round feeding; losses from cattle diseases and poor access to inputs and output market services. In much of Eastern and Southern Africa, the lack of adequate feed (particularly in the mono-modal rainfall areas) and disease challenge, interacting with inadequate veterinary services, inhibit the adoption of dairying by smallholders (Muriuki and Thorpe, 2004).

Dairy production in humid and sub humid region of sub-Saharan region has been constrained by high prevalence of tick-borne diseases and trypanosomiasis resulting in minimum dairy production leading to low milk production. Due to the resultant low milk production densities (litres/km^2), these constraints impose a very high cost on attempts to introduce milk collection schemes and related output market services (Muriuki and Thorpe, 2004).

Therefore, until these interacting inhibitory factors are addressed, increased milk production in the region is likely to continue to result from expansion of the indigenous cattle population and some increase in the proportion of cattle being milked, with relatively little coming from increases in productivity which is usually associated with the use of exotic dairy breeds and their crosses (Muriuki and Thorpe, 2004).

2.3.1 Limitations of breeding technologies and interventions

A major challenge facing breeding programs in Eastern Kenya is the unreliable access to AI services. Liberalization of the AI services in 1993 set the stage for minimal government involvement and a major role was played by private AI service providers, this was as per Sessional Paper No 1 of 1986 on Economic Management for Renewed Growth. However, heavy investment needed in training and acquisition of equipment for provision of AI services means that private AI personnel have to charge higher prices for the service. This has tended to reduce use of the service by majority poor smallholders (Lawrence *et al.*, 2015).

Furthermore, unreliable infrastructure for distribution of semen, inadequate facilitation of private AI service providers and lack of business skills among private AI service providers has compromised the quality of AI services, thus discouraging many farmers from adopting the technology (PPD Consultants, 2013). Indeed, some agro-vets in Eastern Kenya serving as distribution agents for KAGRC have been reported to either employ unqualified staff or use sub-standard equipment incapable of viably storing semen. As a result, some of the semen purchased by AI service providers is dead by the time the animal is served (PPD Consultants, 2013).

The bull scheme has also been plagued by several challenges. First, the cost of keeping a bull is high while the price per service is quite low. Thus, when the frequency of service to other farmers is low, which was often the case, the overall return from these services cannot cover the cost of maintaining the bulls. As a result, farmers charged with the responsibility of maintaining the bulls on behalf of their group members had no option other than to dispose of the bulls.

Dairy production in Kenya is also characterized by poor genetic make-up of dairy herds leading to low productivity in most smallholder dairy farms. Production is also compromised by inadequate feed resources as well as poor quality and high cost of commercial feeds. Feed insufficiency is largely occasioned by increasing population pressure on land resource in high potential dairy regions and this has substantially constrained milk production (Muriuki and Thorpe, 2004). As a result, there is substantial over-reliance on purchased forage and concentrates (Staal, 1999). This compromises dairy productivity since the supply of commercialized forage is subject to seasonality, while concentrates are largely unaffordable to most farmers. Moreover, most smallholder dairy farmers lack managerial and production skills to manage their dairy enterprises profitably. Finally, research sector, which is supposed to generate knowledge and technology for improving performance of the industry, is also inadequately funded. Additionally, transfer of the generated knowledge to farmers is also compromised by the inadequate extension services (Staal and Thorpe.1999).

2.4 Conceptual Frame Work

The model shows the technologies adopted by dairy farmers in an attempt to increase cattle productivity and factors affecting the adoption of dairy farming technologies. The enabling and impeding factors interrelate with each other during the adoption. Increased adoption of dairy technologies translates to increased milk production. (See the figure below)

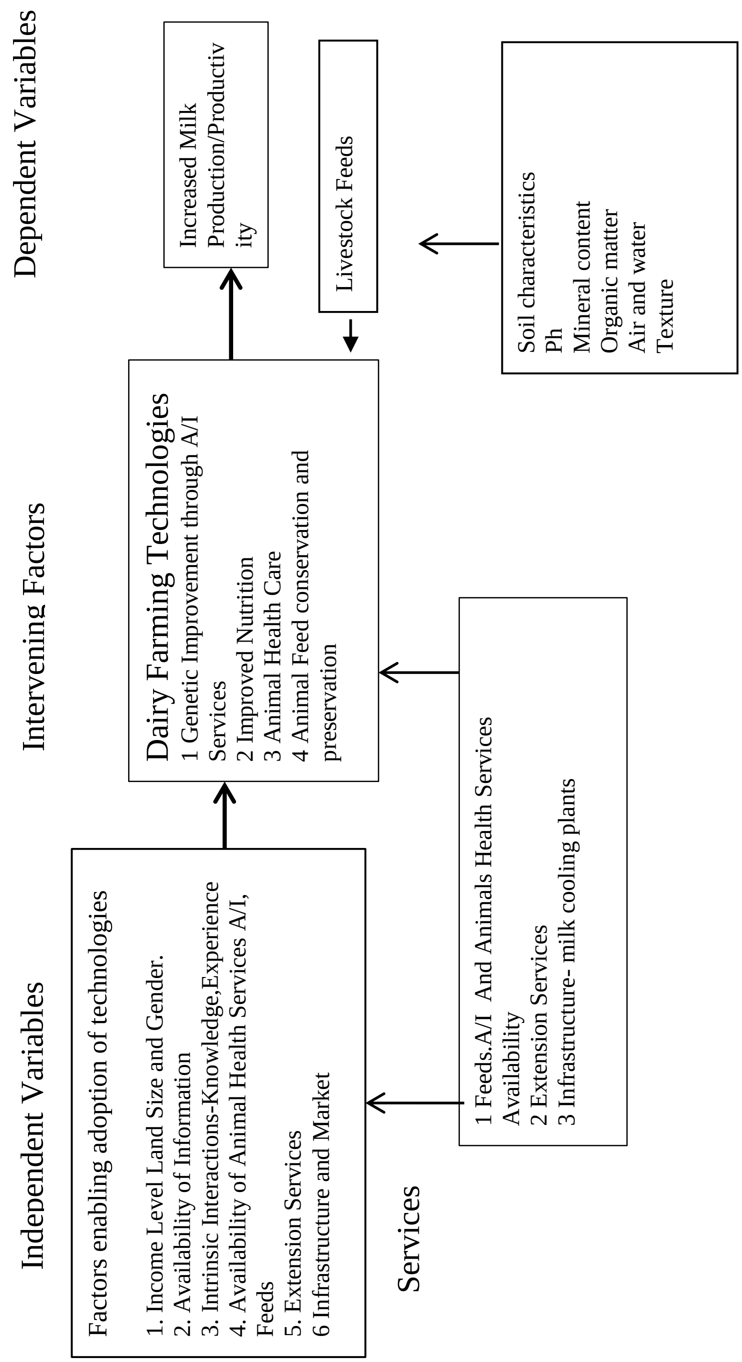

Figure 1. Conceptual model

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 The Study Area

The study area was done in Nzaui Sub-County in Makueni County in the former Eastern province of Kenya (Figure 2). The Sub-County consists of five administrative divisions namely; Mulala, Mbitini, Matiliku, Kalamba and Nguu and has sixteen (16) locations and forty eight (48) sub-locations. It has a population of 116,811 people and 24,562 households with an average farm size of 2.12 hectares with the total area of about 777.4Km^2 (KNBS, 2009). The area is about 160 km from Nairobi. It lies between the longitude 37^0 and 39^0 East and latitude 1^0 to 3^0 South. Most of the land is hilly terrain with some flat area in the division of Nguu. The climate of the area is sub-tropical and it receives an average rainfall of 500mm to 1000mm per annum and daily temperature ranges from 18^{o}C to 32^{0}C minimum and maximum, respectively. The rainfall is bimodal with long rains in March–May and the short rain in October-December; however, the short rains are more reliable than long rains.

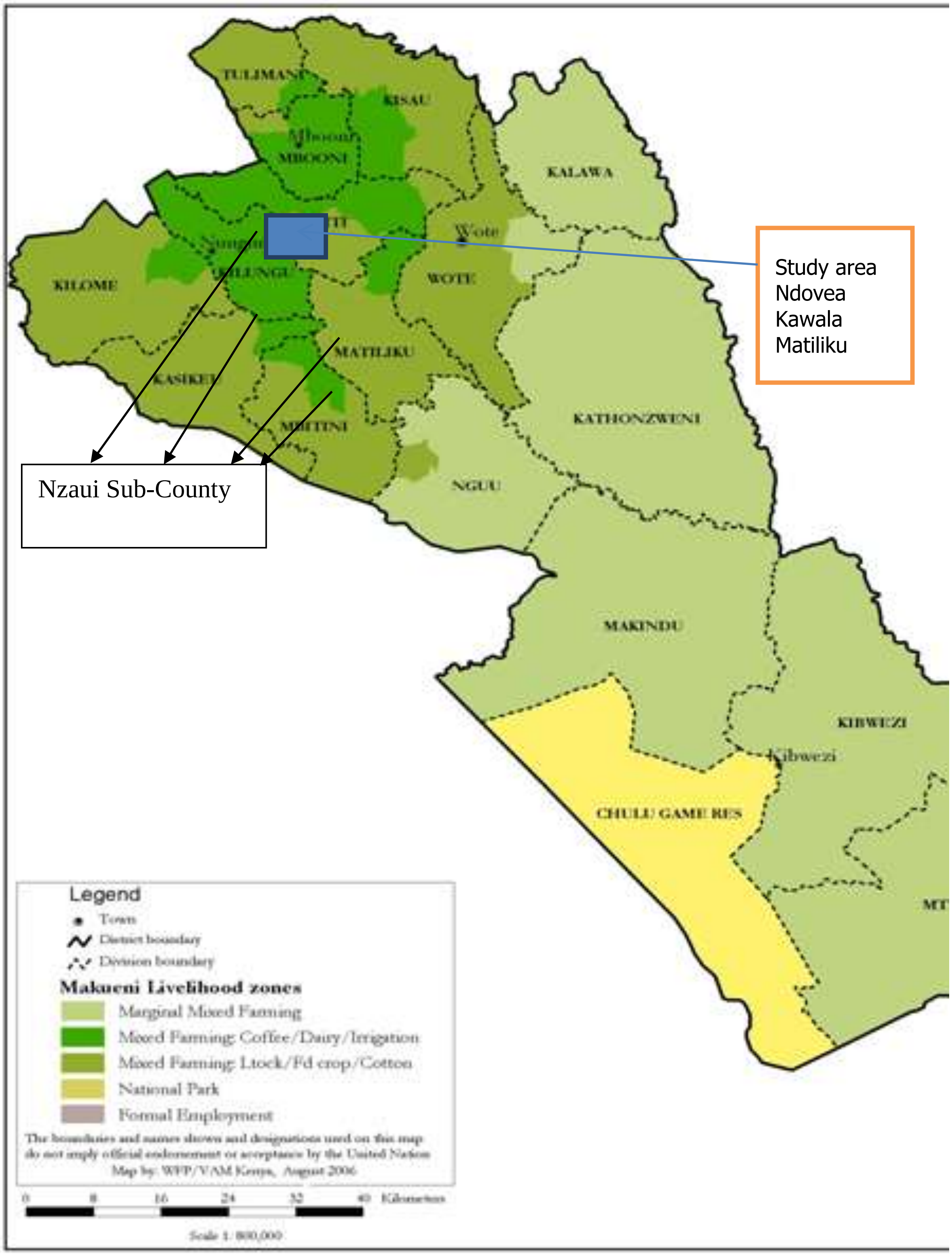

Figure 2: Map of Part of Makueni County showing the study area

3.2 Research Design

Research design can be described as the structure of research (Kothari, 1985; Robson 2002). It is the strategy, plan, and the structure of conducting research. Research design is used to structure the research, to show how all the major parts of the research project fit together.

Descriptive research design is a scientific method which involves observing and describing the behaviour of a subject without influencing it in any way. Descriptive research does not fit neatly into the definition of either quantitative or qualitative research methodologies, but instead it can utilize elements of both, often within the same study. For this survey, both approaches were used. A survey obtains information from a sample of people by means of self-report, that is, people responds to a series of questions posed by an investigator (Kothari, 1985). In this study, a descriptive survey design was preferred because it provided a general account of the characteristics of respondents, for example behavior, opinion and knowledge of a particular situation such as the adoption of modern dairy technologies and its impact on milk yield.

Descriptive research involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data collection (Hopkins *et al.*, 1984). Frequencies were used to aid in understanding the data distribution**.**

3.3 Sampling

Nzaui Sub-County was purposively selected from the 9 sub-counties of Makueni County because of its favorable climatic conditions that supports dairy production. Out of the sixteen locations in the Sub-County, Nzaui and Kawala locations were randomly selected for study. From these two selected locations, Matiliku, Ndovea and Kawala sub-locations were purposively selected for study because of their proximity to the urban centers which offers ready market for dairy products. In the three sub-locations, stratified sampling was used to identify livestock keepers. This was done with the help of key informants such as the location chiefs, assistant chiefs in charge of the sub-locations and the village administrators. The total number of livestock keepers identified where 2482; 842 from Kawala, 543 from Ndovea and 897 from Matiliku.

According to the Central Limit Theorem, any sample greater than 30 follows the normal distribution and a test of significance can be performed (Snedecor and Cochran 1989). According to Mugenda and Mugenda (2003), a test of significance can be performed for a sample of 10% of the total population. The study targeted more than 10% of the total identified number of livestock keepers across the three sub-locations in order to cover cases of non-responses. The researcher allocated numbers to all identified livestock keepers and randomly selected 108, 88 and 110 from Matiliku, Ndovea and Kawala sub-locations respectively. Data was then collected by administering questionnaires.

3.4 Data Collection and Analysis

A pre-tested structured questionnaire was used to collect the data through personal interview at the household of the respondents in the study area. The data collected included the socio-economic characteristics such as, age, formal education status, extension contacts, training on dairy farming, experience on dairy farming and knowledge level of the farmers regarding improved dairy technologies such as fodder production, fodder conservation method, supplementation, improved breeds, total land acreage, land acreage under fodder, household income, off farm household income and the average milk production in the household. In the collection of data on improved breeds, a farmer either had exotic or local breed. Exotic breeds comprised of exotic breeds and their crosses and any farmer who had exotic breeds or both exotic and local was considered to have adopted the technology on improved breeds. The constraints affecting the adoption of modern dairy technologies were identified, ranked and documented.

The primary data collected was qualitative and was coded and used to analyze the extent of adoption of modern dairy technologies of the farmers in the study area. To estimate the extent of adoption of the chosen modern dairy technologies, five selected technologies mainly improved dairy breeds, breeding system, supplementation, fodder production and fodder conservation method were established and their adoption level computed as a percentage of farmers implementing each of them. From the data collected, the most important constraints limiting the adoption of modern dairy technologies were identified and ranked.

Statistical Package for Social Sciences (SPSS) computer package was used to analyze all the data collected. The data was analyzed thematically around issues related to the adoption of the different modern dairy technologies, milk production capacities, socioeconomic descriptions of the respondents in the study site and the constraints limiting adoption of these technologies in the study site.

3.6 Regression model specifications

The most popular models for estimating binary choice models include probit, logit and linear probability (Adesina and Baidu-Forson, 1995). The binary logit model was selected for this study since the dependent variable was binary in nature, it assumed only two values: 1 if the technology was adopted, 0 otherwise. This class of variables is normally determined using logistic regression model that assumes a logistic spread of the error term. The model was also preferred due to consistency of parameter estimation associated with the assumption that error term in the equation has a logistic distribution (Baker 2000; Ravallion 2001). The estimate model is expressed as follows;

The “logit” is the natural log odds of the event, Y=1, that is,

$$\text{logit [p]} = \ln \text{[odds (Y=1)]} = \ln \left[\frac{p}{1-p} \right]$$

Where ; P is the probability of event occuring, Y is the event and ln is the natural logarithm Logit regressions was done to determine the factors that influenced animal types kept, fodder conservation technologies, use of animal supplementation and milk yield levels. The decision to utilize or not to utilize a particular livestock management model is a binary decision. Several socio-economic factors can determine the probability of a smallholder farmer utilizing a given livestock intervention or not.

In this study a logistic regression procedure using maximum likelihood estimation was used to estimate the probability of livestock technologies being utilized (Kmenta, 1986). The specific model described in the equations below was adopted in assessing the socio-economic factors determining adoption of improved dairy technologies (Gujarati 1995).

$Yi = f(Xi, \beta)$--1

Equation 1 indicates a functional relationship (f) between the technologies considered (Y_i) and the independent variables Xi with β being the parameters to be estimated.

The technologies considered for the study included animal type, fodder conservation, animal feed supplementation and milk yield levels. The independent variables considered are; gender of household head, age of household head, marital status, level of education of head of household, main occupation of the respondent, income levels farm size, and access training and extension services on livestock technologies as presented in table 3.1.

Table 3.1 The variable selection table for the 3 logit regression models

Variable	Type of measurement	Considerations
Dependent variables		
Animal type (Regression 1)-Logit	Dummy (1 if Exotic, 0 if local)	
Fodder conservation (Regression 2)-Logit	Dummy (1 if yes, 0 if no)	
Animal feed supplementation (Regression 3)-Logit	Dummy (1 if yes, 0 if no)	
Milk yield levels (Regression 4)-Logit	Dummy (1 if above 5 litres, 0 if below 5 litres)	
Independent variables	Dummy (1 if yes, 0 if no)	
Gender of the household head,	Binary ((1 if Male, 2 if Female))	Gender differences likely to influence improved livestock technologies
Age of household head	Numeric (Years)	Older farmers less likely to adopt improved technologies than young farmers
Marital status of the household head	1, Single, 2, Married	Married households likely to invest in improved livestock systems
Education level of household head	1, None, 2, Primary, 3, Secondary, 4, Tertiary, 5, University	Education improves access to improved livestock technologies and their use
Main occupation of the household head	1, Commercial, 0=subsistence	Farmers with commercial orientation will likely adopt improved livestock technologies than those with subsistence orientation
Income levels	Dummy (1 if N)	Farmers with higher incomes can adopt improved technologies than those with low incomes
Farm size	Numeric (acres)	Famers with larger farms are more flexible and can invest in improved livestock
Access to extension	Dummy (1 if yes, 0 if no)	Access to extension enhances use of improved livestock technologies
Access to training on livestock technologies	Dummy (1 if yes, 0 if no)	Training enhances adoption of improved and specific technologies

CHAPTER FOUR

4.0 RESULTS

From the data collected, out of the 320 questionnaires administered to the households in Nzaui Sub-County, Makueni County, 306 questionnaires were filled and returned. This represented a 96% response rate, which is considered satisfactory to make conclusions for the study. According to Mugenda and Mugenda (2003) a 50% response rate is adequate, 60% good and above 70% rated very well. This implies that based on this assertion; the response rate which was calculated in this case was according to Mugenda and Mugenda was very good.

4.1 Dairy technologies and milk production capacities

4.1.1 Modern dairy technologies adoption levels

The results shown variation of adoption levels of various dairy technologies in the study sites and these levels differ across the three sites. In terms of livestock ownership, 87% (266) farmers owned local zebu livestock while 13% (40) farmers owned exotic livestock. In Matiliku, there were 13% of farmers adopting exotic livestock, while there were 4% in Kawala and 25% in Ndovea (Figure 3).

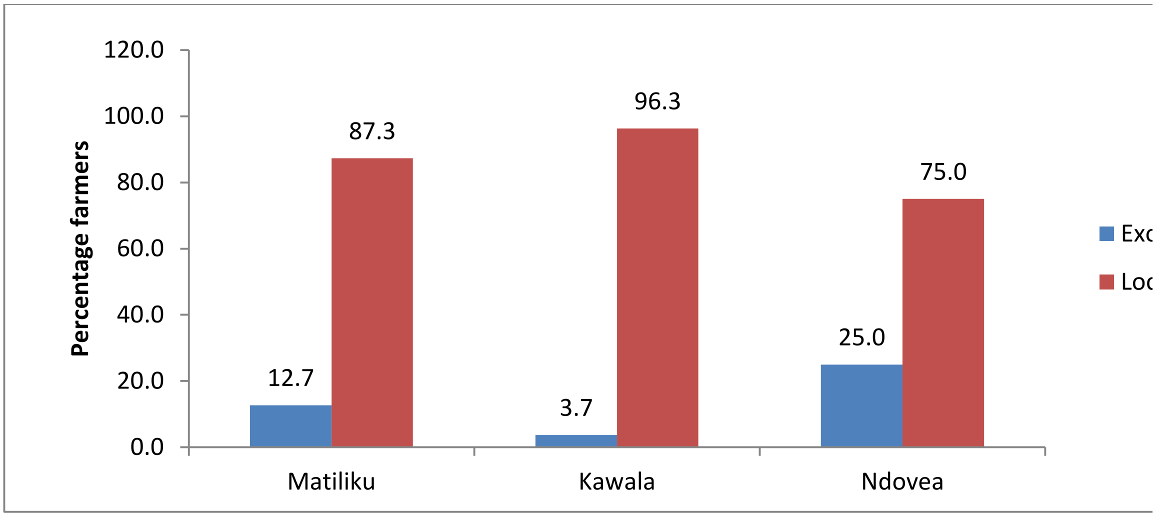

Figure 3: Frequency of adoption levels of cattle breeds technology (%).

4.1.2 Milk production capacities

In terms of average milk yields, there were 78 % (240) farmers getting less than 5 litres per cow per day and 20% (62) of the farmers received 5-10 litres of milk per day per cow. Only 1 farm from Kawala received 11-15 litres of milk per day per cow. Milk yields were significantly associated with sites p=.003 (Table 4.1).

Table 4. 1: Milk yield by sites in the selected study sites

Milk yields	Matiliku	Kawala	Ndovea	Total
below 5lts	84(76.4%)	96(88.9%)	60(68.2%)	240(78.4%)
5-10 lts	26(23.6%)	11(10.2%)	25(28.4%)	62(20.3%)
11-15 lts	(0.0)	1(0.9%)	3(3.4%)	4(1.3%)
Grand Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Pearson χ^2 (4) = 16.1903 Pr = 0.003. Counts and parenthesis are percentages

Source- Author

A total 248(81%) of respondents depended on breeding animals for livestock replacement while 19% purchased their livestock to supplement their stocks. This was significantly associated with sites. There was no significant linkage between livestock ownership and replacement (p = .227) (Table 4.2).

Table 4.2: Sources of livestock replacement (%)

Stock replacement	Matiliku	Kawala	Ndovea	Total
From breeding animals	94(85.5)	88(81.5)	66(75.0)	248(81.0)
Purchase	16(14.5)	20(18.5)	22(25.0)	58(19.0)
Grand Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Pearson χ^2 (4) = 5.1012 Pr = 0.277 counts and parenthesis are percentages Source- Autho

78% of the farmers used any bull, while 8% use either AI or dairy bulls and 12% dairy bulls for breeding purposes. In Matiliku, 65% of farmers used any bull with 91% in Kawala and 81% in Ndovea site. There was a significant association between sites and adopted breeding technologies. (p ≤.000) (Table 4.3).

Table 4.3: Frequency of adoption levels of breeding systems technology (%)

Breeding system	Matiliku	Kawala	Ndovea	Total
Both AI and dairy bull	21(19.1%)	1(0.9%)	1(1.1%)	23(7.5%)
Any bull	71(64.5%)	98(90.7%)	71(80.7%)	240(78.4%)
AI only	4(3.6%)	1(0.9%)	1(1.1%)	6(2.0%)
Dairy bull only	14(12.7%)	8(7.4%)	15(17.0%)	37(12.1%)
Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Pearson χ^2 (6) = 41.7128 Pr = 0.000 counts and parenthesis are percentages

Source- Author

Farmers in the study area mostly gave supplements to livestock (63%), while 38% did not give livestock supplements. In Matiliku, 64% of the farmers gave supplements to their livestock supplements while this level was higher in Ndovea (75%), with the least level of supplementation in Kawala (52%). Supplementation and sites in the areas were significantly associated. (p ≤.004) (Table 4.4).

Table 4.4: Frequency of adoption levels of supplementation technologies (%)

Supplementation	Matiliku	Kawala	Ndovea	Total
No supplement	40(36.4)	52(48.1)	22(25.0)	114(37.3)
Supplement given	70(63.6)	56(51.9)	66(75.0)	192(62.7)
Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Pearson χ^2 (2) = 11.1736   Pr = 0.004 counts and parenthesis are percentages

Source- Author

In Matiliku, there were 93% farmers storing fodder under trees, 92% in Kawala and 85% in Ndovea. In addition, there were 15% of farmers using bales in Ndovea. Across sites, there were 85% and 15 % of farmers using tree storage (for shading) and 15% using bales. (Figure 4).

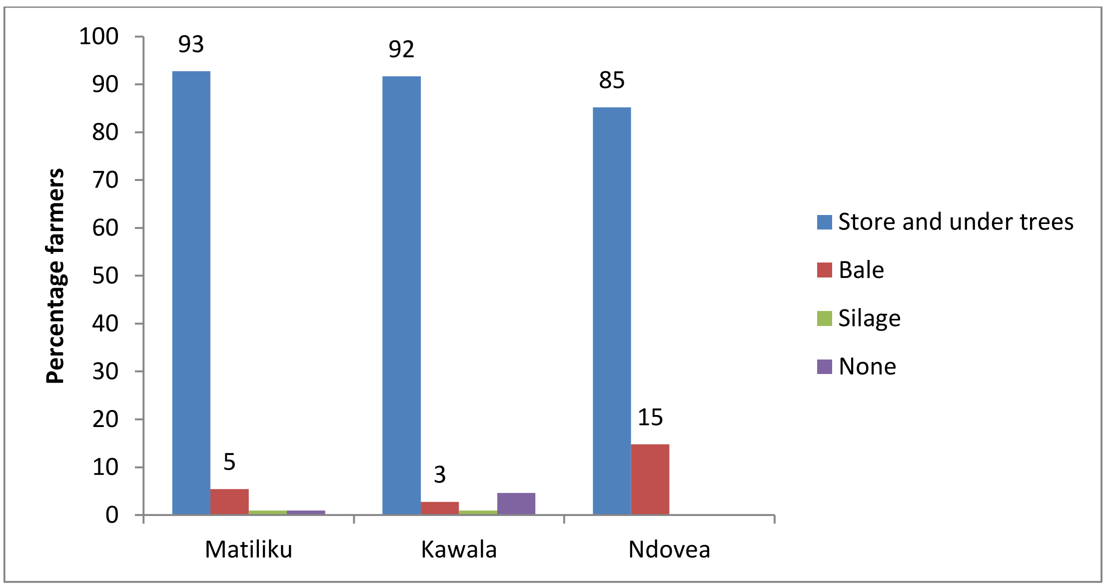

Figure 4: Frequency of adoption levels of fodder conservation technology (%)

4.2 Description of the socioeconomic characteristics of livestock farmers in the study sites

The demographic data seeks to establish the general information of the respondents. From the questionnaire, the following profiles of the respondents were established: gender, age bracket, education levels, their land size, marital status, their milk sources, and occupation and income levels.

In the study sites there were more male respondents (77%) than females (23%). Across the study sites Male respondents were 86%, 78% and 65% in Matiliku,Kawala.and Ndovea respectively. Gender and site were was significantly linked in the area,. (χ^2 = 11.8256, df=2, p ≤. 0.003) (Table 4.5).

Most respondents were in aged blanket of 35-50 years (56%) in all sub locations. In Matiliku, 67 farmers were 35-50 years old, and 36% (39) were above 50 years old (Table 4.2). While in Kawala and Ndovea, this age-set comprised 50% and 56% of the sample respectively. The age distribution was not significantly linked to sites. (p ≤.0.557). Respondents were categorised into levels of education. Literacy is a critical component in accessing agricultural information and contributes significantly to the adoption of dairy technologies. In each of the study sites, over 50% of the respondents attained primary school education, about 30% attained secondary school education. 5%, 13% and 9% of the respondents in Matiliku, Ndovea and Kawala respectively did not attain any level of schooling. There was significant variation in the level of education across the three sub-locations (p ≤. 0.001) (Table 4.5).

Respondents in each of the study sites were categorised into marital status as married, single or widow. Majority of the respondents in each of the study sites were married with Matiliku having the highest number of married respondents at 89%, 84% in Kawala and 73% in Ndovea. In relation to the maritals status, there were 86% of respondents who were married and 11% being widowed and 4% of the respondents being single. There was no significant linkage between marital status and sites (Table 4.5).

Land is critical in any farming enterprise, in the area majority of the farmers(53%) have between 2-5 acres of land, while less than 2 acres are owned by 27% of the farmers which limits their production capacity. Farmers who had more 5 acres were 20%. There was no significant linkage between land ownership and sites (Table 4.5).

The study showed that most of the farmers derived milk from own livestock. 70% of the milk is obtained from their own cows, 4% from the goats (4%) while 26% of the farmers bought their own milk. 92% of farmers in Matiliku get from milk from their own cattle, 76% in Ndovea and 44% in Kawala. There was a significant association between milk sources and sites. (χ^2= 69.0578, df=8, p ≤.0.000) (Table 4.5).

Farming was the main occupation of the majority of the respondents in the three sub locations with 46%, 70% and 66% from Matiliku, Ndovea, and Kawala respectively. This was followed by Farmer/business in the three sub locations with Ndovea having the highest number of respondents at 22% and Matiliku the least at 7% respondents engaged in both farming and business. In total, there were 60% farmers, 14% farmers and businessmen, 14% casuals and 10% salaried respondents. Occupation and sites were significantly associated according to the chi-square test (χ^2 = 46.8920, df=8, p ≤. 0.000)

The study shown that most respondents in the three sub locations receive of less than Ksh. 6000 per month (47%), 6000-12000 (37%) as incomes. Matiliku leads with 84%, Ndovea 78% and Kawala 77% of the respondents indicating their earnings are below Ksh.12000 per month. Income levels and sites are significantly associated (χ^2=46.076, df = 4, p ≤. 0.000) (Table 4.5).

Table 4. 5: Respondents socio-demographic characteristics and site

	Matiliku (110)	Kawala (108)	Ndovea (88)	Total	Chi-square
Gender					
Male	94(85.5)	84(77.8)	57(64.8)	235(76.8)	χ^2=11.826, df=2, p ≤. 0.003^xx^
Female	16(14.5)	24(22.2)	31(35.2)	71(23.2)	
Age set					
below 35yrs	4(3.6)	5(4.6)	5(5.7)	14(4.6)	χ^2=3.007,df=4,p ≤.0.557^ns^
35yrs-50	67(60.9)	54(50.0)	49(55.7)	170(55.6)	
above 50yrs	39(35.5)	49(45.4)	34(38.6)	122(39.9)	
Education level					
Secondary	31(28.2)	36(33.3)	33(37.5)	100(32.7)	χ^2=22.6383, df=6, p ≤. 0.001^xx^
Primary	61(55.5)	57(52.8)	45(51.1)	163(53.3)	
Post-secondary	13(11.8)	1(0.9)	1(1.1)	15(4.9)	
None	5(4.5)	14(13.0)	9(10.2)	28(9.2)	
Marital status					
Married	98(89.1)	91(84.3)	73(83.0)	262(85.6)	χ^2 = 5.283, df=4, p = 0.259^ns^
Widow	7(6.4)	15(13.9)	10(11.4)	32(10.5)	
Single	5(4.5)	2(1.9)	5(5.7)	12(3.9)	
Land size categories					
less than2	37(33.6)	30(27.8)	16(18.2)	83(27.1)	χ^2 = 6.132, df=4, p= 0.190^ns^
2-5 acres	52(47.3)	58(53.7)	52(59.1)	162(52.9)	
above 5 acres	21(19.1)	20(18.5)	20(22.7)	61(19.9)	
Milk source					
Cow	101(91.8)	47(43.5)	67(76.1)	215(70.3)	χ^2 = 69.058, df=8 p ≤. 0.000^xxx^
Buy	5(4.5)	55(50.9)	18(20.5)	78(25.5)	
Sheep	1(0.9)	(0.0)	(0.0)	1(0.3)	
Goat	3(2.7)	6(5.6)	3(3.4)	12(3.9)	
Occupation					
Farmer and business	8(7.3)	15(13.9)	20(22.7)	43(14.1)	χ^2 = 46.8920, df=8, p ≤. 0.000^xxx^
Casual	28(25.5)	10(9.3)	5(5.7)	43(14.1)	
Farmer	50(45.5)	76(70.4)	58(65.9)	184(60.1)	
Business	3(2.7)	2(1.9)	(0.0)	5(1.6)	
Salaried	21(19.1)	5(4.6)	5(5.7)	31(10.1)	
Income levels					
above 12000	21(19.1)	9(8.3)	24(27.3)	54(17.6)	χ^2)=46.076, df=4, p ≤.p 0.000 ^xxx^
below 6000	30(27.3)	74(68.5)	39(44.3)	143(46.7)	
6000-12000	59(53.6)	25(23.1)	25(28.4)	109(35.6)	
Training					
Attended	46(37.3)	46(42.6)	65(73.9)	152(49.7)	χ^2=29.531, df=2, p ≤. 0.000 ^xxx^
Not attended	69(62.7)	62(57.4)	23(26.1)	154(50.3)	
Extension service					
On time	105(95.5)	92(85.2)	83(94.3)	280(91.5)	χ^2=8.651, df=2, p ≤. 0.013 ^ns^
Not on time	5(4.5)	16(14.8)	5(5.7)	26(8.5)	

Note ^xxx^ significant at 1%.^xx^ significant at 5% ^x^ significant at 10% ,^ns^ –not significant. Counts and parenthesis as percentage.

4.3: Social Economic Factors influencing livestock technologies adoption

4.3.1: Social economic Determinants of animal types kept in farms

The main factors that were significant in affecting whether farmers kept exotic livestock included gender, with male-headed farms more likely to keep exotic cows compared to female-headed farms. Marital status was significantly associated with keeping exotic livestock, because married families were associated more with exotic livestock than households of singles as increasing the married level by 1 unit increases the odd of adopting exotic livestock by 0.473 times which is significant at 10% (p ≤.0.021). Increased household income by 1 level increased the odds of adopting exotic livestock 8.6 times which is significant at p ≤. .000 (Table 4.6).

Table 4. 6: Social Economic Factors influencing animal types kept in farms

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender of head	-.749	.325	5.331	1	**.021**	.473
Age	.412	.283	2.116	1	.146	.662
Education	.012	.225	.003	1	.956	1.012
Marital status	1.006	.374	7.216	1	**.007**	.366
Land size	.368	.245	2.264	1	.132	1.445
Occupation	1.581	.738	4.593	1	**.032**	4.860
Income level	2.149	.244	77.552	1	**.000**	8.577
Training	-.262	.343	.583	1	.445	.770
Extension	.678	.523	1.682	1	.195	1.971
Constant	-5.606	1.553	13.029	1	.000	.004

B- co-efficients SE- standard error wald-wald statistics Df - degree of freedom, sig- significant. Exp(B)- exponential of natural logs(odds)

Source- Author

4.3.2: Social Economic Determinants of fodder conservation technologies

In terms of using fodder conservation technologies, married families were 0.276 times more likely to conserve fodder than single families (p ≤.032). Increasing training by one unit increases the odds of fodder conservation by 0.304 times while extension increases the odds of fodder conservation by 0.303 times (Table 4.7).

Table 4. 7: Social Economic Factors for fodder conservation technologies

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender of head	-.271	.549	.244	1	0.621	.762
Age	.320	.380	.707	1	0.400	1.377
Education	-.267	.366	.532	1	0.466	.766
Marital status	1.287	.602	4.579	1	**0.032**	.276
Land size	.129	.345	.139	1	0.709	1.137
Occupation	1.888	1018.766	.000	1	0.999	1.575E8
Income level	-.422	.285	2.198	1	0.138	.655
Training	1.192	.550	4.694	1	**0.030**	.304
Extension	-1.193	.536	4.964	1	**0.026**	.303
Constant	-9.120	10187.666	.000	1	0.999	.000

B- coefficients SE- standard error . wald-wald statistics.Df - degree of freedom, sig-significance Exp(B)- exponential of natural logs.

Source- Author

4.3.3: Social Economic Determinants of use supplements to the of animals

In regards to using supplements to the animals, significant variables included age, occupation, income level, and training. The odds of using animal supplementation increased by 0.714 by increasing age with 1 level, while commercial occupations were associated with animal supplementation by a 0.121 increased likelihood. Increased income level by 1 level (more than 6000 Kshs/month) increased odds of using animal supplementation technologies by 1.492 times, while training increased the odds of adopting feed supplementation by 0.055 times (Table 4.8).

Table 4. 8: Social Economic Factors affecting feed supplementation technologies

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender of head	-.233	.263	.783	1	0.376	.792
Age	-.337	.203	2.749	1	0.097	.714
Education	-.254	.177	2.058	1	0.151	.776
Marital status	-.424	.292	2.099	1	0.147	.655
Land size	.183	.180	1.037	1	0.308	1.201
Occupation	2.111	.795	7.048	1	0.008	.121
Income level	.400	.161	6.187	1	0.013	1.492
Training	2.893	.249	135.536	1	0.000	.055
Extension	-.008	.361	.000	1	0.983	.992
Constant	8.652	1.472	34.541	1	0.000	5718.776

B- co-efficients SE- standard error . wald-wald statistics. Df - degree of freedom, sig-significance Exp(B)- exponential of natural logs.

Source- Author

4.3.4: Social Economics Determinants of milk productivity levels

Production levels of milk from the cows is determined by various factors such as land acreage, marital status, trainings and income. Marital status was associated with increased milk yield, with more married households likely to achieve more than 5 litres per day by 0.531 times more than single households. Farmers who had more land size by increased unit land sizes were likely to achieve more than 5 litres per day, 2.2 times more than farmers who had less land. An increment of incomes by more than Ksh6000per month, led to likelihood of more milk yields by more than 5 times while training had a 0.3 times more likelihood of increasing milk yields. (Table 4.9)

Table 4. 9: Social Economics Determinants of milk productivity levels

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender of head	-.093	.299	.097	1	0.755	.911
Age	.086	.244	.124	1	0.725	1.090
Education	-.038	.200	.036	1	0.850	.963
Marital status	-.632	.332	3.634	1	**0.050**	.531
Land size	.780	.222	12.382	1	**0.000**	2.182
Occupation	-.486	.885	.302	1	0.583	.615
Income level	1.643	.182	81.365	1	**0.000**	5.170
Training	1.122	.296	14.345	1	**0.000**	.326
Extension	.041	.518	.006	1	0.937	1.042
Constant	-2.858	1.585	3.252	1	0.071	.057

B- co-efficients SE- standard error . wald-wald statistics.Df - degree of freedom, sig-significance Exp(B)- exponential of natural logs.

Source-Author

4.4 Challenges in adoption of dairy technologies

The main constraint faced by farmers in the study site is lack of feed; approximately 93% of the respondents ranked it as the most common and less most common. This was followed by the cost of dairy animals at 84% while access to breeding services and poor infrastructure and were not ranked as major constraints, 13% and 4%respectively. Table 4.10

Table 4. 10: Constraints in the adoption of dairy technologies (%)

Constraint	Rank	Matiliku	Kawala	Ndovea	Total
Cost of dairy cattle	Most Common	43 (39.1)	15 (13.9)	9 (10.2)	**67 (21.9)**
	Less most Common	48 (43.6)	76 (70.4)	65 (73.9)	**189 (61.8)**
	Less most Common	11(10)	10 (9.3)	13 (14.8)	**34 (11.1)**
	Common	8 (7.3)	7 (6.5)	1 (1.1)	**16 (5.2)**
	Total	**110 (100)**	**108 (100)**	**88 (100)**	**306 (100)**
Lack of feeds	Most Common	54 (49.1)	90 (83.3)	75 (85.2)	**219 (71.6)**
	Less most Common	40 (36.4)	14 (13)	11 (12.5)	**65 (21.2)**
	Common	10 (9.1)	4 (3.7)	2 (2.3)	**16 (5.2)**
	Not Common	6 (5.5)	0 (0)	0 (0)	**6 (2)**
	Total	**110 (100)**	**108 (100)**	**88 (100)**	**306 (100)**
Poor Infrastructure	Most common	4 (3.6)	0 (0)	0 (0)	**4 (1.3)**
	Less most Common	7 (6.4)	2 (1.9)	0 (0)	**9 (2.9)**
	Common	39 (35.5)	23 (21.3)	14 (15.9)	**76 (24.8)**
	Not Common	60 (54.5)	83 (76.8)	74 (84.1)	**217 (71)**
	Total	**110 (100)**	**108 (100)**	**88 (100)**	**306 (100)**
Inadequate access to breeding services	Most Common	3 (2.7)	2 (1.9)	2 (2.3)	**7 (2.3)**
	Less most Common	9 (8.2)	11 (10.2	12 (13.6)	**32 (10.5)**
	Common	52 (47.3)	67 (62)	58 (65.9)	**177 (57.8)**
	Not Common	46 (41.8)	28 (27)	16 (18.1)	**90 (29.4)**
	Total	**110 (100)**	**108 (100)**	**88 (100)**	**306 (100)**

Counts and parenthesis are percentages

Source-Author

4.5 Effects of livestock development constraints

Most of the farmers indicated that poor infrastructure affected input transport (feed transport, 88%) and the transportation of outputs to the market (8%) (Table 4.11)

Table 4. 11: Effects of poor infrastructure on transportation of farm produce (%)

Effect	Matiliku	Kawala	Ndovea	Total
Transport of feed	92(83.6)	94(87.0)	82(93.2)	268(87.6)
Other	7(6.4)	2(1.9)	5(5.7)	14(4.6)
Transport of milk to market	11(10.0)	12(11.1)	1(1.1)	24(7.8)
Grand Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Counts and parenthesis are percentages

Source-Author

In regards with access to breeding services, the effects includes poor milk yields of 56%(173 farmers), extra use of inputs to realise better yields 17% (52 farmers) and poor breed quality 52% (81 farmers) of all the respondents in all the sublocations. This was a major challenge in Ndovea and Kawala, compared to Matiliku (Table 4.12).

Table 4. 12: Effects of poor access to breeding services on milk yields (%)

Effect	Matiliku	Kawala	Ndovea	Total
Poor milk yield and low production	37 (33.6)	75 (69.4)	61 (69.3)	173 (56.5)
Poor breeds due to lack of proper AI and Dairy bull	67(60.9)	12(11.1)	2(2.3)	81(26.5)
Extra inputs to realize better yield	6(5.5)	21(19.4)	25(28.4)	52(17.0)
Grand Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Counts and parenthesis are percentages

Source-Author

In regards to weather patterns, the effects on livestock production included fluctuating milk yields (23%), increased costs of inputs (23%), livestock diseases (4%), and livestock feed challenges (50%) across the sites (Table 4.13).

Table 4. 13: Effects of weather patterns on animal production (%)

Effect	Matiliku	Kawala	Ndovea	Total
Fluctuation of milk yield	33(30.0)	28(25.9)	8(9.1)	69(22.5)
Diseases	7(6.4)	4(3.7)	1(1.1)	12(3.9)
Increase in cost of inputs	25(22.7)	28(25.9)	18(20.5)	71(23.2)
Others	(0.0)	1(0.9)	(0.0)	1(0.3)
Feeding system	45(40.9)	47(43.5)	61(69.3)	153(50.0)
Total	110(100.0)	108(100.0)	88(100.0)	306(100.0)

Counts and parenthesis are percentages

Source-Author

CHAPTER FIVE

5.0 DISCUSSION

The technologies adopted in the area includes rearing of exotic breeds and crosses, use of both AI and a dairy bulls in the cattle breeding programs , proving supplements to animals, production of fodder and conserving it. Fodder conservation in the areas mainly involves storing under trees and stores. From the results obtained, levels of adoption of these different technologies were of different extents in that a question on each of these technologies in each of the study sites were administered to all the respondents. In the entire study site, 13% keep exotic breeds and crosses, 23% use modern breeding technologies to breed their animals, 63% do feed supplementation to their animals and 90% do fodder conservation. It is evident that fodder conservation is leading in the level adoption in the study site followed by feed supplementation to their animals. The method of fodder conservation is however not modern since most farmers place their fodder in stores and under trees. These findings are in line with those of Ndathi *et.al*. (2013), who observed that most farmers do not conserve the harvested feeds well mainly due to inadequate skills and lack of conservation structures. For most of the rangelands, the main methods remain leaving them standing in the fields, harvesting and placing them in tree branches, on wooden racks or in small home granaries, Ndathi *et al*. (2013).

The adoption levels across the three study areas are varied however due to various reasons. In Matiliku, the adoption level of fodder conservation is 93% which was higher than the other sites (Ndovea 85% and Kawala 92%) and this could been explained by the fact that there are more farmers with higher monthly income, (53.6%) of between ksh 6000-12000 which is higher than that of the other sites (Ndovea 23.1% and Kawala 28.4%). On education status, Matiliku has more respondents with post-secondary education (11.8%) than other sites which implies high income and education tends to influence the fodder conservation technologies and such farmers have been exposed to new technologies through education and have extra income to invest in them, therefore these farmers can afford to invest new technologies. Ndovea is the least in fodder conservation because this study site is rural where extension service is rare. The use of AI as a breeding method is higher other in Matiliku (3.6%) as compared to locations because of factors such as market availability, ease of information access from agricultural and extension services and the scarcity of land which limits the rearing of bulls. The dominant cattle breed in the study sites is Zebu which is reared by 87% of the respondent in the study sites. Dairy breeds are yet to be embraced in the area. With low adoption levels (13%) of dairy cattle, Dairy management practices tend to be very low as evidenced by only 2% of the livestock farmers use A.I. services to breed their animals in the entire study site.

On average, daily milk production per cow in the entire study site is below 5 litres with 78.4% of the livestock farmers sampled indicating that is their production capacity. This is mainly due to the rearing of Zebu which is kept by 87% of the livestock farmers with only 13% keeping exotics and crosses, with these low levels of production, some households have to buy milk for their consumption.

Generally, the study reveals that, dairy cattle together with use of modern breeding systems as the least dairy technologies embraced in the area. This study finding are in line Letha (2013) who indicates new dairy technologies are not being used by many dairy farmers and this has resulted to low milk production and productivities.

The key socioeconomic characteristics that have a direct effect on the adoption of dairy technologies include education levels, land size, occupation, income levels, and gender of household head. Literacy is a critical component in accessing agricultural information and contributes significantly to the adoption of modern dairy technologies. In the study site, more than 80% of the respondents have attained primary schooling which hinder them accessing more agricultural information. However, relating this to adoption of the dairy technologies implies that farmers are constrained by some factors such as income, since majority of these farmers have income of less than Ksh. 12000 per month which makes it difficult to meet cost of dairy breeds as well as other costs related to the adoption of these technologies.

Farmers with more land acreage are more likely to produce more milk per day. There is more adoption of fodder conservation in Matiliku than the other two study sites because most of the respondents have high income, are more educated and exposed to new technologies. This finding is in line with Kabunga (2014) who stated that, there is a positive association between farm size and adoption, implying that the likelihood of adoption is higher for farmers with more land. From the findings majority were male respondents at 77% with 23% being female respondents. This implies there were more male headed households than female ones in the entire study site. Some studies such as that by Kabunga (2014) reveal that female-headed households are more likely to adopt improved dairy cows. This could explain the low levels of adoption of dairy breeds in the study sites since majority of the households are headed by male. This was in contrast to Shibeshi (2017) findings that male households were more likely to adopt improved livestock technologies than female household.

Age is a critical component in determining whether the livestock farmers were old enough to provide reliable insights relevant to the study. In the study site, 57% of the respondents were between 35-50 years old and therefore old enough to provide reliable information in arriving at these findings.

Income levels of the respondents in the study site constrained the adoption levels of the dairy technologies since majority of the respondents at 82% earned income of less than Ksh. 12000 per month. Due to the cost implications in the adoption of this technology, low income earners have less adoption levels than the high-income earners. These views support those by Murithi (1990), that if the amount of resource use is increased, then there should be substantial increase in milk production. Although majority of the respondents in the study site at 60% were farmers, adoption of dairy breeds does not equate to this number of respondents meaning farming was mainly on non-dairy breeds.

The main constraints identified are lack of feed and high cost of dairy breeds at 93%and 84% respectively while poor access to breeding services (13%) and poor infrastructures (4%) were considered to not be a major constraints in the entire study site. Lack of feed is attributed mainly to the effects of prolonged drought, poor land use resulting in land degradation and other effects of climate change (Gikaba *et al.,* 2014). Lack of feed in the study site has however promoted the uptake of fodder conservation technologies in the study site. High cost of dairy breeds limits farmers ability to purchase the breeds and thus farmers opt for the local breeds mainly Zebu whose milk productivity is poor. Poor access and high cost of breeding services leads to farmers rearing poor cattle breeds whose cost of management is very high and productivity is low.

Factors which influenced farmer rearing of improved animal types included; gender, marital status, and income levels. With respect to fodder conservation technologies, the most important factors included marital status (0.276, $p \leq 0.032$) training (0.303, $p \leq 000$ and extension (0.304, $p \leq 030$). The adoption of animal supplementation was influenced to a great extent by income levels (1.492, $p \leq 0.013$) and occupation (0.212, $p \leq 0.008$) rather than household endogenic factors. In regards to milk yield, this was influenced to a great extent by marital status (0.531, $p \leq 0.050$), land size (2.182, $p \leq .000$), income (5.170, $p \leq .000$) and training (.326, $p \leq .000$). This implied that a unit increase of these factors will increase the level of adoption of these technologies by indicated odds. And that farmers with larger farm sizes, more incomes and training access were better placed to achieve high milk yields than those with lesser of those characteristics.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study concludes that among the five-identified modern dairy technologies, only fodder conservation and supplementation technologies have a higher adoption levels while that of keeping dairy cows and use of modern breeding methods have low levels of adoption. The main breeds kept in the study area are Zebu implying milk production capacity is low. This therefore reveals that for farmers to realize improved milk yield in the study site, the modern dairy technologies under study should be embraced concurrently and key focus should address the key constraints limiting farmer's ability to adopt these technologies. The study concludes that in regards to animal type, house-hold factors and resource availability were major factors. Gender was a major factor which moderated the types of animals kept but not fodder conservation technologies, supplementation or milk yield levels. Fodder conservation was influenced by marital status, training and extension contact. This shows that training was important for farmers with respect to fodder conservation technologies. Milk yield was influenced by several factors including house-hold endogenic factors (marital status, income), farm factors (farm size), and external factors (training)

6.2 Recommendations

The study recommends that's

- There is need for different players to create awareness on dairy technologies in the areas so that more farmers can embrace it to improve their living standards and income
- There is need to provide farmers with credits facilities to enable them purchase improved dairy breeds to increase their sources of income.
- There is need to enhanced extension services in area so that farmers can access to training improved livestock technologies, This can be achieved by posting more extension agents to the area since they are few in study site.

- There is need for further research on adoption of modern dairy technologies and its impacts on milk production in other agricultural marginal regions in the country in order to have comprehensive study on the effects of adoption of modern dairy technologies.

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APPENDICES

Appendix 1: QUESTIONNAIRES

SURVEY ON AWARENESS AND ADOPTION OF MODERN DAIRY TECHNOLOGIES

My name is Elijah Kijogi Matiri, a student at South Eastern Kenya University. I am conducting a research on factors affecting adoption of modern dairy technologies and its impact on milk production in Nzaui Sub-County, Makueni County, in partial fulfilment for a Master Science Degree in livestock Production Systems in the School Agriculture and Veterinary science. Your contribution in answering this questionnaire is critical and highly appreciated for the success of this study. This study is only for academic purposes and remains confidential therefore do not indicate your name or any other identification detail on this questionnaire.

INSTRUCTIONS:

Fill only one set of the questionnaire per individual.

Please answer each question as completely and clearly as possible by ticking appropriately on only one answer (unless otherwise advised) from the choices given or writing your response as appropriate in the space provided.

Questionnaire Number__________________ **Date _______________**

District:______________________________

Division: _____________________________

Location: _____________________________

Sub-location:__________________________

Part A: Demographic Data

Please put a tick (√) against the answer of your choice.

1. Gender: Male ( ) Female ( )

2. Age of respondent (HH)
   (1) Below 35yrs
   (2) Between 35-50 yrs
   (4) Above 50yrs
3. Education levels of respondent (HH)
   (1) Never attended school
   1. Primary level
   2. Never Secondary level
   3. Post-secondary level
4. Marital status (HH)
   (1) Single
   (2) Married
   (3) Widowed

SECTION A: Social Economic characteristics of farmers (HH) and modern dairy technologies

5. What is the size of your land?

i. Less than 2 acres
ii. Between 2-5 acres
iii. Above 5 acres

6. What are the sources of milk used by house hold?

i. Own Goats
ii. Own Sheep
iii. Own Cows
iv. I buy

7. What is the main occupation of the household head?

i. Formal employment-salaried

ii. Informal employment-casual works

iii. Business

iv. Farmer

v. Farmer and business

8. Other (Specify) ____

(a) Subsistent

b) Commercial

9. What is the level of the inco me for the head of the household per month?

i. Below ksh. 6,000/=

ii. Between ksh. 6,000/= to ksh. 12,000/=

iii. Above ksh 12,000/=

SECTION B: Social economic characteristics of farmers and modern dairy technologies

10. What types of cattle do you keep for milk production?

i. Exotic breeds and their crosses

ii. [`Local /zebu

iii. None

11. What are the sources of the r eplacement of your exotic breeds (dairy animals)

i. Purchase

ii. From breeding my animals

12. What methods do you use for breeding your dairy animals?

i. Dairy Bulls only

ii. A/I only

iii. Any Bull

iv. Both A/I and Dairy bull.

13. What is the average yield of milk per day per your dairy cow

i. Below 5 litres

ii. Between 5 – 10 litre

iii. Between 11- 15 litres

iv. Between 16 – 20 litres

v. Above 20 litres.

14. In your farm, how many acres do you reserve for fodder/grass cultivation

i. None

ii. Less than 5

iii. Between 5-10

iv. Between 11-15

v. Above 16

15. Do you normally practices fodder conservation?

i. Yes

ii. No

16. What methods of fodder conservation do you normally practices?

i. Bale preparation

ii. Silage preparation

iii. None

iv. Storage the fodder in store/under trees.

v. Other (specify______________________________

17. Do you supplement you animals with concentrates?

i. yes

ii. no

18. Have you attended any training on livestock production?

i. Yes

ii. No

SECTIONC: Constraints affecting the adoption of modern dairy technologies

19. In animal production, do you receive extension services on time?

i. Yes

ii. No

20. If NO, give reasons

____

____

____

21. Are you affected by lack of feed in the production?

1. Yes
2. No

22. If Yes, please explain how

____

____

____

23. How does poor infrastructure?

i. Transportation of feeds
ii. Transportation of milk to the market
iii. Other (Specify) __________________

24. How does inadequate access to breeding services affect the modern dairy technology?

i. Lowers milk production
ii. Poor breeds due to lack of proper AI and Dairy bull
iii. Poor milk yield due to poor breeds
iv. Extra inputs to realize better milk yield
v. Other (Specify) __________________

25. How does a changing weather condition affect the modern dairy technology?

i. Fluctuation of milk yield
ii. Diseases
iii. Increase in cost of inputs
iv. Expensive feeding system
v. Other (Specify) __________________

26 In the rate of **1 to 5;** indicate to what extent the problems affect the farmers in the animal production. (1-most common problem to 5 less common problem)

Challenges	**1**	**2**	**3**	**4**	**5**
Cost of dairy cattle					
Lack of feeds					
Poor infrastructure					
Inadequate access to breeding services					