FACTORS INFLUENCING DAIRY GOAT MILK PRODUCTION IN KITUI TOWNSHIP, KYANGWITHYA EAST AND KYANGWITHYA WEST WARDS OF KITUI CENTRAL SUB COUNTY

BY:

MUSYOKA STEPHEN MUTUKU

(Bsc. Range Management, UON)

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DECLARATION

I declare that this thesis is my original work and has not been presented for a degree in this or any other University

Stephen Mutuku Musyoka

J56/KIT/20140/2012

Signature……. Date……

We confirm that the work reported in this thesis was carried out by the candidate under our supervision and has been submitted with our approval as University supervisors.

Professor Titus I. Kanui, BVM, PhD.

Department of Range and Wildlife Sciences

School of Agriculture and Veterinary Sciences

SOUTH EASTERN KENYA UNIVERSITY

Signature……. Date……

Dr. Simon Nguluu, Bsc, MSc, PhD.

Department of Dry Land Agriculture

School of Agriculture and Veterinary Sciences

SOUTH EASTERN KENYA UNIVERSITY

Signature……Date……

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This work is dedicated to my wife Josephine Kanini Mutuku for her continued prayers, love, encouragement and support during the period of the study. I also dedicate it to my children Mercy Kasungwa Mutuku and Eric Musyoka Mutuku who encouraged me and promised to emulate me in their studies and Lewis Mutua Mutuku who was born during the study. I also dedicate it to my mother Pauline Kaindi Musyoka and other family members for their prayers and support. God bless you all.

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ACRONYMS AND ABBREVIATIONS

AEZ – Agro-Ecological Zone

ALRMP – Arid Lands Resource Management Project

ANOVA – Analysis of variance

ASAL – Arid and Semi-Arid Lands

ASARECA – Association for Strengthening Agricultural Research in Eastern and Central Africa

CCPP – Contagious Caprine Pleuro Pneumonia

CBO – Community Based Organization

CAHW – Community Animal Health Workers

CDK – Catholic Diocese of Kitui

DANIDA – Danish International Development Agency

DGAK – Dairy Goats Association of Kenya

DLPO – District Livestock Production Officer

FAO – Food Agriculture Organization

FDA – Focal Development Area

FGDs – Focused Group Discussion

FM – Frequency Modulation

IEBC – Independent Electoral and Boundaries Commission

ILCA – International Livestock Centre for Africa

KAP – Kitui Agricultural Project

KDC – Kitui Development Centre

KNBS – Kenya National Bureau of Statistics

LGP – Length of Growing Period

MOLD – Ministry of Livestock Development

NGO – Non-governmental Organization

SEAG – Small East Africa Goat

SPSS – Statistical Package for Social Science

TV – Television

USDA – United States Department of Agriculture

ABSTRACT

Low goat milk yield is a major constraint in Kitui County. A survey was carried out in Kitui Township, Kyangwithya east and Kyangwithya west wards of Kitui Central Sub County to assess and document the factors influencing dairy goat milk production and its roles towards improvement of rural livelihood. The environmental and managerial factors affecting milk production of different goat breeds was surveyed. Data was collected through questionnaires, observation and recording, and photography. Interviews were on household and weather characteristics, social, economic and management activities of the household keeping dairy goats. Multi-stage and purposive sampling techniques were used to select 90 respondents from the two agro ecological zone within the survey area and the data collected was analyzed using statistical package for social scientist software. Most of the households had less than five family members and were headed by men mostly with basic primary education. Rainfall was found to affect milk production levels with the March to May rains having more effects on milk production than the October to December rains. Semi-arid part received less rainfall than the sub humid part and was more prone to feed shortages during the dry season. Household farm holdings were found to be small characterized by low soil fertility levels due to over utilization. Feed supplementation and frequency of watering of goats was found influence milk production levels. Adoption of goat housing and disease control management such as dipping and drenching were, found to influence milk production levels by controlling both external and internal parasites and reducing housing management related diseases and pests such as diseases such as pneumonia, orf, flea and lice among others. Buck rotation and exchange was the common way of minimizing inbreeding with a few famers using castration. Education levels, experience in goat keeping and membership to self-help groups was also found to influence milk production levels across the two breeds. Similarly, household income sources and accessibility to credit was found to positively affect milk production levels. Most of the respondents reported increased income levels through sale of live animals (culls and off springs), milk, meat, manure, skins, cheese, and sale of buck service with much of the income being used to buy food and pay school fees. Household nutrition was increased across all family members including the old and children. Sensitizing farmers on proper animal husbandry practices, proper water harvesting techniques, providing them with drought resistant pasture and fodder seeds and availing credit facilities is recommended as a way of increasing milk production and improving rural livelihood of farmers within the study area

CHAPTER ONE

INTRODUCTION

1.0 Background of the study

Various communities of the world have practiced goat production since their domestication around 10,000-11,000 years ago (Alizadeh *et al.,* 2003). Goats thrive in wide climatic conditions ranging from cold and wet temperate zones to the hot and dry tropical areas. Globally, there are about 460 million goats, producing over 4.5 million tons of milk and 1.2 million tons of meat (Haenlein and Donald, 1994), besides provision of other social and economic goods and benefits such as hair, income, leather, and dung for fuel and fertilizer. World dairy goat population is estimated to be 15 million (Devendra, 1982). The role and potential contribution of goats to increased milk production is impeded by the controversy about their destructive habits to the environment (Devendra, 1999). However, economically goats serve as saving and living banks for the resource poor rural people, since they are easily converted to cash when a need arises (Dossa *et al*., 2008; Gurmesa *et al*., 2011). Goats are useful for emergencies such as tax payments, hospital bills, school fees, payment of debts and purchase of food items during crop failure (Shirima, 2005; FAOSTAT, 2010).

Goats serve as a source of protein in humans and are used during ceremonies and festivals. They are a stable source of income for the poor in the rural areas as well as an asset for dowry settlement. Dairy goat farming is a suitable enterprise for improving the living standards of the rural poor through increased incomes and nutrition.

Compared to dairy cattle, dairy goats have better production attributes as, they breed at a younger age, have short production cycle, are cheaper to acquire; eat less food and produce milk; have multiple births; are easy to handle and represent a smaller loss in the event of death (Devendra and Burns, 1980). Dairy goats are “a poor man’s cows”, are affordable by the poor farmers because of low initial and maintenance costs.

Additionally, any member of the family including women and children can attend them (Mahmoud, 2010).

In Kenya, dairy goats' population is low (estimated at 251,100) (MOLD, 2011) compared to meat goats (estimated at 17.2 million). Even though this percentage is small, their role in providing milk is widely recognised, especially by the poor farming households. Dairy goat breeds in the country are dominated by Alpines, Toggenburg, Saanen, Anglo-Nubian; and crosses with local breeds. Although dairy goat farming in Kenya dates back to 1950s' among the white settlers, it was not until1980s' when intensive promotion begun (MOLD, 2006). This was through an integrated small livestock project sponsored by the Germany government and scaled up around Mt. Kenya with an objective of creating employment within the community and enhancing market access of dairy goats and their products by the poor rural farmers (Eik *et al*., 2008; Safari *et al*., 2008).

Dairy goat farming in Kitui County was introduced in 1999 by Kitui Agricultural Project (KAP), funded by the Danish Government as a strategy of addressing poverty through increased milk production and income generation, since poor households could not afford to keep dairy cattle (MOLD, 2012). Over the years, more development agents like Farm Africa, Arid Lands Resource Management Project (ALRMP), Catholic diocese of Kitui (CDK), Kitui Development Centre (KDC) and World Vision ventured in goat promotion and now their population has increased tremendously. Reports from the field by the farmers and extension officers estimate milk production per goat per day to be below 0.75 litres (DLPO, 2012). For instance, reports from Mulundi FDA which is within the study area estimated an average production level of less than 2 litres per goat per day (DLPO, 2002). Similarly, in 2006 farmers in Mbusyani, which is also within the study area, reported an average daily production level of 1 litre of milk per goat per day (DLPO, 2006). This is contrary, to the normal expectation from a dairy goat whose milk production vary between 2 to 4 litres (DGAK, 2009). Currently many Community based organizations (CBOs) working with resource poor livestock keepers in medium to high

potential areas are encouraging them to keep improved goat genotypes, which are cross bred between exotic temperate and indigenous tropical goats (Ahuya *et al.*, 2009).

1.1 Statement of the problem

Increasing human population is demanding for high returns but less land requirement production enterprises. Dairy goat farming has emerged as a high-return option for the small-scale farmers especially in the Central and Mount Kenya regions (Kinyanjui *et al*., 2010), but in Kitui County; the benefits enjoyed by dairy goat farmers in other areas are not realized. The average milk production per goat has remained low (DLPO, 2002; 2012). In 2012, extension officers reported a production level of between 0.5 litres to 0.75 litres of milk per goat per day signifying a decreasing trend (DLPO, 2012).

This decline may relate to the type of land ownership, farm sizes and rainfall pattern and distribution that has resulted to the failure in fodder establishment (Verbeek *et al*., 2007). In response to reducing farm sizes, farmers have adopted zero grazing and tethering techniques, which are associated with limited feed material, minimal nutrients to the animals and low productivity. Low-income levels among the farmers have resulted to inadequate feed supplementation, poor routine animal husbandry practices and inaccessibility to high value breeding material. The original breeding material introduced in the country has not been replenished over a long period leading to inbreeding depression (Gipson, 2002). Proper selection and mating schemes are important in reduction of inbreeding depression and improvement of productivity (Kosgey, *et al.*, 2006).

1.2 Justification

After introduction of dairy goat farming in Kitui County by Kitui agricultural project (KAP), more development agents like Farm Africa, World vision, Arid lands Resource Management Project (ALRMP), Catholic diocese of Kitui and Kitui development Centre(KDC) came up with more dairy goat initiatives including farmer capacity building (DLPO, 2007). However, there was no proper documentation on the levels of milk

production by different dairy goat breeds under different environmental and socio-economic environment.

The objective of this study was to examine and document social, economic and environmental factors affecting goat milk production levels.

The study looked at milk production levels by different goat breeds (exotic and indigenous) within two agro ecological zones (semi-arid and sub humid). The study extended what was studied by (Ahuya *et al.*, 2009) who carried out similar study in one ecological zone (highlands of Kenya) addressing several production parameters of one breed (Toggenburg) and what was studied by (Chenyambuga *et al*., 2012) by addressing general production performance of one breed (Toggenburg) but in two ecological zones (semi-arid and sub-humid areas) of Tanzania. This study fills the gap by extending the work done by the two researchers since it looked at the milk production levels of different goat breeds (exotic and indigenous) in two ecological zones (semi-arid and sub humid areas) and how they inter relate to social economic and cultural environment.

Considering the previous work done as cited above, this study was more detailed as it addressed one parameter across various breeds over a wider ecological condition and under different managerial and socio-economic set ups. The study also involved dairy goat farmers within the study area who were in organized farmers' groups or those who were not. Dairy goat farmers were those who kept one or more dairy goat or their crosses (DGAK, 2009). The study results will act as guide to farmers in selecting the best breed and the management systems that suit their ecosystem for maximized milk output for their own benefits and community.

Development agents like CBOs, county governments and national governments, will use the results to source the best breeding material for the specific ecological zone. The study derives recommendations which can lead to improved productivity at household level and

hence lead to increased food security and living standards of the residents of the study area in question.

1.3 Objectives

1.3.1 Broad objective

The broad objective of the study is to assess, analyse and document the factors influencing dairy goat milk production in Kitui Township, Kyangwithya east and Kyangwithya west wards of Kitui Central Sub County

1.3.2 Specific objectives

The specific objectives were:

1. To establish the environmental factors affecting milk production in different goat breeds.
2. To establish the management factors affecting milk production in different goat breeds.
3. To assess the socio-economic factors influencing dairy goat milk production.
4. To assess the role played by dairy goat keeping towards improvement of rural livelihoods.

1.4 Research questions

The following are the research questions for the study

1. Which environmental factors affect milk production of different goat breeds?
2. Which management factors affect milk production of different goat breeds?
3. What are the socioeconomic factors affecting dairy goat milk production?
4. Does dairy goat keeping play any role towards improvement of rural livelihoods?

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical background of dairy goat farming

Goats (*Capra hircus hircus*) were among the first animals domesticated by man in around 10,000-11,000 years ago. Since then, they have been providing man with various social and economic uses. Archaeological data suggest that goats were first domesticated in the Euphrates river valley at Nevali Cori, Turkey and in Zagros Mountains of Iran (Alizadeh *et al.*, 2003).

There are about 460 million goats in the world, producing over 4.5 million tons of milk and 1.2 million tons of meat besides mohair, cashmere, leather, and dung for fuel and fertilizer. Dairy goats make only about 3.3% (15 million) of the world goat population. In Kenya, their population is about 251,100 while that of meat goats is 17.2 million (MOLD, 2011). Ninety eight percent (98%) of all the goats in Kenya are indigenous with main breeds being the small East Africa goat (SEAG) and the Galla reared under extensive systems in arid and semi-arid areas (ASAL). Alpines, Toggenburg, Saanen, Anglo-Nubian, and their crosses with local goat breeds dominate the dairy goat population in the country. Eight five percent of dairy goats are found in the higher rainfall areas of Central, Eastern and Rift Valley regions, where they are kept under intensive (zero - grazing) and semi-intensive systems. The goat breeds under consideration here are exotic goats (Alpines and Toggenburgs), indigenous goats (Small East Africa goats and Galla) and their crosses since they are the common breeds within the study area. Milk from local goats (Small East African goat, Galla goats, and their crosses) makes a considerable contribution to food security in the sub county (MOLD, 2011). Dairy goats are best adapted to temperate zones and their production in tropical areas is therefore reduced (Devendra and McLeroy, 1982; Hetherington, 1996).

In Kenya white settlers started promotion of Dairy goats in the 1950's but it was not until 1980's when the government of Germany sponsored an integrated small livestock project that scaled up dairy goat activities around Mt. Kenya. Some of the objectives of the project were to improve income and nutrition, create employment within the community and enhance market access by the poor rural farmers (Eik *et al*., 2008; Safari *et al*., 2008). As the project came to an end in the year 1993, farmers came together through registered groups and formed the Dairy Goats Association of Kenya (DGAK) for sustainability of dairy goat projects. In Kitui Central Sub County, dairy goat farming was started in 1999 by Kitui Agricultural Project (KAP), a project funded by Danish government as a strategy of addressing poverty (DLPO, 2002; 2012).

2.2 Environmental factors affecting milk production of different goat breeds

Goats survive in a wide climatic condition ranging from cold and wet temperate zone to the hot and dry tropical areas. Goats are easy to keep in comparison to other livestock species (Sebei *et al.,* 2004). Goats are particularly important animals in subsistence agriculture and accounts for their unique ability to adapt and maintain themselves in a wide ecological condition including dry and harsh environments.

The most important adaptive features enabling them to adjust to these varying environments are feeding behaviour, body size and fleece structure (Horst, 1984). Goats that inhabit hot, humid environments have small bodies (dwarfs), while those living in dry environments or in areas with a wide diurnal temperature range usually have larger bodies. The environmental variation does not only influence body sizes but also milk production and according to (Chenyambuga *et al.,* 2012), average daily milk yield in sub-humid areas exceeded that in semi-arid areas by about 0.3 liters per day. Similarly, (Güney *et al*., 2006, Norris *et al*., 2011) reported that different goat breeds produce different quantities of milk under the same ecological set up.

The environmental conditions in consideration here are weather elements mainly rainfall and temperatures. Soil type and fertility, and frequency of diseases and pests are also considered as environmental factors which can affect milk production. Manure from dairy goats provides many environmental benefits, by helping farmers increase the soil fertility of their small farms (Juma and Ciamarra, 2013). In areas where cattle are of lesser importance, manure produced by the goats is of special importance Nawathe *et al.*, (1985). According to (Orindi *et al.,* 2006) and (Recha *et al*., 2013) agricultural production is constrained by the inadequate rains and frequent droughts leading to crop failure and scarcity of pastures while (Kabirizi *et al*., 2013) noted that climatic limitations affect feed availability, quality of the feeds, animal performance and farm production.

Although precipitation has positive correlation to the forage production and milk production, its excess in poorly housed animals can cause pneumonia. With adequate rainfall farmers can improve the quantity and quality of forage to provide nutrients sufficient for maintenance and production of approximately 5.0 kg/d of milk Trail and (Trail and Gregory, 1981). The type of soils will also impact on forage production in that infertile soils will lead to low quality forage which has effects on milk production. During the dry season, the quality of feeds is low such that does lose weight and body conditions in addition to low birth weight of the kids born and hence forth reduced milk production (Ben Salem and Smith, 2008).

Different goat breeds have different adaptive characteristics that enable them to respond differently to weather elements of sub humid and semi-arid areas. Sub humid zone is also termed as ecological zone III and lies between 900-1800 m above sea level with an annual rainfall of between 950 and 1500 mm. The estimated length of growing (LGP) period for forage is between 180 and 210 days. The ecological challenges of sub humid areas include fast-maturing grasses (high rate of lignifications), high temperature, moderate humidity, and possible infestation by tsetse flies (Peters and Horst, 1981). Hot temperatures had greatest stress effect on pregnant goats followed by young non-pregnant and lactating goats (Busono *et al.,* 2012). For the goats to survive in sub humid weather

conditions they should exhibit physical and physiological adaptations such as medium to small body sizes, short to medium hair and light skin (Banerjee *et al.*, 2000) to manage the high temperatures and humidity. The digestive system should be adapted to deal with high lignifications.

Semi-arid areas are those that lie in agro ecological zone IV with an altitude of almost the same agro ecological zone III (900 – 1800 mm above sea level) though it might be lower (Sombroek *et al.,* 1982). They are characterized by erratic and poorly distributed rainfall ranging between 500 – 1000mm per annum and a soil moisture index of 25 - 40%. The length of growing period is between 90 to180 days (Sombroek *et al.,* 1982). This zone is favorable for indigenous goats and has relatively less adaptability problems for the high producing exotic breeds (Banerjee *et al,* 2000). The environmental constraints in semi arid areas, which both exotic and indigenous goats must overcome include, seasonal availability of vegetation, predominance of bush and shrub plants, inadequate surface water, high radiation, and large fluctuations in diurnal temperature. Indigenous goats are more adaptable to low feed intake, harsh environmental conditions and limited water resources (El-Nouty *et al.,* 1990) while majority of exotic dairy goat breeds in Kenya are found mainly in the high and medium potential rainfall areas (Okeyo, 1997).

The goats should therefore be physically and physiologically adapted to survive on scarce vegetation with preference for browse, high in selective feeding, larger body size and insulating coat. They should also have high digestive efficiency for coarse roughages, good water metabolism system, more tolerance to tannins, and high disease resistance (Horst, 1984). The weather conditions are conducive for ecto and endo parasites that have detrimental effects on milk production therefore farmers must improve their level of management.

Although exotic goats will produce more milk in sub humid areas than indigenous goats due to their high breeding value, their susceptibility to diseases is highly rated (Ahuya *et al.,* 2009). Both exotic and indigenous goats kept in a sub-humid environment perform relatively better in terms of milk production compared to those in a semi-arid

environment, while those in semi-arid areas do well in terms of reproductive performance and meat production (Chenyambuga *et al.,* 2012). On average, exotic goats in sub humid areas produce 2 to 3 litres per day although this varies with breed and the level of management. Indigenous goats (Galla and Small East Africa goat) survive well in hot, low attitude climate and don't like cold wet climates and are able to produce between 0.5 to 0.75 litres per day (Bosman *et al*., 1997; Kosgey *et al*., 2006).

Milk production for exotic and indigenous breeds in semi-arid areas is low in comparison to sub humid areas due to depressed quantity and quality of forage. According to (Chenyambuga *et al.,* 2012), the average daily milk yield in sub-humid areas exceeded that in semi-arid areas by about 0.3 liters per day. Milk production of exotic goats in semi-arid areas ranges between 1.5 to 2 litres while those of indigenous goats range between 0.3 to 0.5 litres although this varies with breed and level of management (Bosman *et al*., 1997; Kosgey *et al*., 2006).

2.3 Management factors affecting milk production of different goat breeds

The management activities considered during the study was, feeding management, housing management, diseases management and breeding management. Though goats can be kept in a wide range of agro-ecological zones and under different management systems in Africa (Peacock, 1996), the socio-economic status of the households is key to their productivity. Different ways of management have evolved in response to factors such as climate, needs of the owner, socio economic environment, and level of technology available (Haenlein, 1996). Income and literacy levels of household heads are important indicators of the socio-economic status of a household and can dictate the land endowment, adoption and management.

The level of management and adoption of new technologies is also influenced by gender, religion and culture of a community (Kagunyu *et al.,* 2010). Different management and socio-economic environment can therefore have positive or negative effects on levels of milk production. Improved capacity of farmers has a long-term effect on milk

productivity (Kaberia *et al*., 2003) since challenges in relation to breeding, disease control, housing, watering and feeding regimes that have negative effects on milk production can be successfully addressed (Ahuya *et al.,* 2009). The main management activities practiced by farmers include, feeding which also involves watering and supplementation, disease management, housing and breeding management. Different ways of management have evolved in response to factors such as climate, needs of the owner, socio economic environment, and level of technology available (Haenlein, 1996).

Income and literacy levels are important indicators of the socioeconomic status of a household and can dictate the land endowment, adoption and management.

Farm size holding is the single most important indicator that dictates the kind of grazing and management systems that households can adopt. In most humid and sub humid areas of Kenya, though rapid increase in population has resulted to high demand for milk, it has also led to diminishing land sizes associated with acute fodder shortage thus necessitating farmers to rear high producing livestock breeds under zero grazing and tethering systems. Farmers are therefore forced to adapt to the situation by ensuring that they provide feed, water, proper housing and disease management to have profits. They therefore must learn new technologies on fodder establishment, conservation and utilization since (Midau *et al.*, 2010) reported that milk output of the doe drops with decrease in the quantity and quality of fodder and increasing Napier yields substantially increases milk yields (Muriuki, 2003). According to (Salama *et al.*, 2005) the quality and quantity of fodder given to does prior and after parturition, influences milk yield, milk quality, lactation length, kid vitality and growth rate.

When rainfall is inadequate, farmers with small hectares of land tend to experience feed shortage in most of the months due to inadequate knowledge on pasture establishment techniques and conservation (Njarui *et al*., 2009). Fodder production techniques must be adopted as coping strategy of addressing feed shortages during the dry season in Kenya (Lusweti *et al*., 2005). Inadequate and shortage of feed materials has been a common

challenge among farmers thereby forcing them to supplement their dairy goats for good results. Supplementing goats frequently with different types of feed supplements especially leguminous tree leaves boost their productivity (Leng, 2003). According to (Kabirizi, 2009) adding 1 kg of calliandra daily to a diet of Napier, lablab and homemade concentrate increased the daily milk production of a cow by 0.7 litres. Similarly, according to (Berhane and Eik, 2006), a supplement of 0.5kg of dairy cow concentrates should be given to dry goats; 1kg of the concentrates for 1litre of milk for milking doe and additional 0.5kg for every extra litre. Ignorance and high costs of concentrates is a major challenge to feed supplementation and routine disease management practices especially to farmers practicing extensive grazing systems (Onim, 1992).

According to (Kinyanjui *et al.*, 2010), an exotic goat and local goat give an average of 2 to 3 litres and 0.5 litres to 0.75 litres per day respectively under good management system however, if poorly managed, they can produce less than 1 litres and less than 0.3litres of milk per day respectively. Change of milk production output from the normal mean is higher in exotic goats than indigenous goats due to tolerance of environment and nutritional stresses (McDowell, 1989). Poor management especially tethering which is a common practice among farmers with small farm holdings can be associated with accidental death, theft and predators. Although exotic breeds are good producers than indigenous goats, they are more prone to stress and highly susceptible to diseases hence require good management in terms of housing and disease control. Proper goat housing design can help mitigate individual aggressiveness of dairy goats (Nordmann *et al.*, 2011). Goat housing has been practiced by farmers since time immemorial though not all goats are properly housed (Alvarez and Gutierrez, 2010). According to (Olechnowicz and Jaskowski, 2011) lameness was a high-risk factor for housed goats due to feet being consistently wet in excreta with bacteria.

Season of kidding also affects the total milk yield and according to (Zahraddeen *et al*. 2009), milk yield in goats was higher during the wet season than the dry season. High

temperatures experienced in semi-arid areas are a major cause of heat stress that is detrimental to milk production and reproduction in dairy animals (Voltorta *et al*., 2002). Animals producing higher levels of milk production are more sensitive to heat stress (Hahn, 1989; Johnson, 1987). Temperature and precipitation alterations increase disease and parasite incidences, which in turn increases animal mortality and reduces productivity (Baker and Viglizzo, 1998). Likewise (Mohd and Yogendran, 2009) reported that the problem of low milk production by purebred goats can be tested by separating from heat stress and tropical disease load by housing them continuously in hygienic climate-controlled all-steel barns.

Breeding management which involves proper selection and matching the genotype to its environment reduces stress, increases milk production and productivity generally and is more beneficial to the farmer. Breeding management involves practices like, culling, selection, castration, buck exchange and rotation. Buck rotation and buck exchange should be maintained to ensure that there is no inbreeding among the goats. Proper buck selection should be done by looking at phenotypic characteristics such as the testis, penis, horns, jaws, feet and skin colour. Genetic characteristics can only be assessed by looking at the performance of both parents on characters like milk production, birth rate, twining rate and susceptibility to diseases among others. A successful functional breeding and sound examination system for bucks should incorporate libido test scores, body conformation or testicular traits evaluation (Kerketta *et al.,* 2012). One buck should be kept for 30 to 40 does and exchange or rotated after one and half years. According to (Thongchumroon *et al.,* 2011), in order to establish an effective goat breeding improvement program there is need for an accurate identification of best bucks and does through well-planned breeding objectives, selection and mating programs. Selection and culling which has been practiced for a long time is a normal production strategy aimed at ensuring that the nonproductive stock including the low yielders and the old are removed from the flock for sale or slaughter. This allows the farmer to remain with only good producers and hence improving production and gross margins. Temperate breeds produce

more milk than tropical breeds (Güney *et al*., 2006; Norris *et al*., 2011) under their favorable environmental condition.

Tropical breeds have low milk yield due to their low genetic potential and prevailing environmental conditions like stress caused by harsh weather and diseases.

Genetic differences among the dairy goat breeds affect ash and fat contents of the milk, and tropical breeds give higher percentage of these contents than temperate breeds (Schmidely *et al*., 2002; Zahraddeen *et al*., 2007). According to (Kaberia *et al.,* 2003) for a dairy goat farmer to successfully increase milk production from the goats it is prudent to ensure that diseases are put on check by ensuring there is regular vaccination, regular spraying or dipping against ecto parasites and that they are fed with foods containing all the required nutrients to control metabolic diseases. According to (Mellado *et al*., 2003) that kids born with low birth weight were more likely to die and less likely to conceive with high risk of abortion when they became adults hence having direct effect on milk production.

2.4 Social and economic factors influencing dairy goat milk production

In livestock production enterprises, complex interactions of environment, biological and socio-economic variables affect productivity (Omore, 1998). Productivity when applied to livestock refers to either level of production or efficiency of production (James and Carles, 1996). Goat keeping enterprise (both indigenous and exotic) whether under extensive or intensive management system must require inputs to realize outputs. However, the levels of inputs invested in the enterprise vary from farmer to farmer depending on the goals and objectives. Land, feeds, water, labour, drugs and housing are the most important inputs that a farmer must put in place before engaging in the enterprise. Socio economic challenges like diminishing land parcels and changing cultural lifestyles has negative impacts on adoption and sustainability of goat enterprises.

The type of grazing and management systems adopted by households is determined by its farm size. It will determine whether a farmer will do zero grazing, tethering or extensive grazing. Increasing land pressure and urbanization has made dairy goat production under

intensive system an attractive option for smallholders in rural and semi-urban areas (Fagerholm *et al*., 2011). In this case, farmers must adopt new technologies on feed supplementation, disease control and housing to maximize outputs. Low literacy and low-income levels have subjected farmers to poor animal husbandry practices like, inadequate feed supplementation, poor housing and disease control leading to low production. Where there is communal land ownership, farmers practice semi intensive and extensive grazing system with little inputs invested to the enterprise and marginal outputs realized. To achieve self-sufficiency in, milk, and other livestock products, the government should establish a livestock development strategy to ensure an efficient livestock disease control system and strengthen research in livestock breeding to upgrade the quality and productivity of the present livestock breeds (MAAIF, 2001).

2.4.1 Social factors

In most African countries, culture dictates that women are subordinates to men, are socially marginalized and have no room for decision making on how to utilize animals, e.g., they cannot destock or restock goats in the absence of husbands (Manjeli *et al.*, 1996). This has a direct influence on breeding and selection. Culture also dictates that women should remain at home while husbands attend seminars (CIMMTY, 1993), and yet do not always teach the women the skill they have learnt in the extension meetings.

Age on the other hand can affect the level of dairy goat milk production since it can determine the level of adoption of a technology. For instance, older farmers may have more experience, resources and authority that provide them more possibilities of improving production (CIMMTY, 1993). The organization of farmers into self-help groups and associations is also a key factor to sustainability of the enterprise in question (Adesina and Forson, 1995). Participation in learning activities related to fodder shrubs, often through groups, lead to successful uptake and increased production (Wambugu *et al.* 2003; Franzel and Wambugu, 2007) while (Maina, 2009) suggested that membership in community groups using a certain technology was likely to lead to better adoption of the technologies by more farmers and translate into other advantages.

According to (Devendra, 1999), the ownership of goat's increases as land gets scarcer. The poorest people find food and financial security in the ownership of these animals.

The education level of the farmers has a long-term effect on milk productivity (Kaberia *et al*., 2003). Education creates a favorable mental attitude for the acceptance of new practices in agriculture which in turn improve productivity (Caswell *et al.*, 2001) while (Wozniak, 1984) reported a positive significant relationship between education and adoption of technologies. Experience and education will assist farmers understand and manage selective breeding which is correlated to milk production. According to (Makokha *et al.,* 2008) and (Kinambuga, 2010) dairy farmers use their past experience in dairying to control the risks associated with dairying and have better control of diseases and management of dairy cattle. Older farmers have more experience in farming and are better able to assess the characteristics of modern technology than younger farmer (Adesina and Forson 1995). Level of milk production varies within the breeds (Kendall *et al*., 2009). Although cross breeding is a quicker way of realizing genetic improvement than selection, where selection has been done correctly, milk production will tend to increase from a foundation goat to an intermediate, from intermediate to appendix with a pedigree in the same breed producing the highest quantities of milk (Ahuya *et al*., 2009).

Inbreeding is more common in small populations and difficult to avoid in populations that routinely use modern reproductive technologies, such as artificial insemination and embryo transfer (Bijma *et al.,* 2001; McDaniel, 2001; Weigel, 2001). Higher producing breeds, such as Alpine, Saanen and Toggenburg, have higher inbreeding depression for average standardized milk, fat, and protein yields than lower producing breeds, such as LaMancha and Nubian (Gipson, 2002).

Poor government policy on regulation of breeding has enhanced practicing farmers sell low quality breeding material to new farmers since there is no law curtailing them from practice. According to (Makkar *et al.,* 2007) an appropriate policy formulation and institutional building can support dairy goat farming, provide attractive market for goat

milk, encourage milk processing industry and improve production for both local use and for export.

2.4.2 Economic factors

The main economic constraint prevailing in rural communities is the lack of viable economic base such as inadequate capital for investment, lack of skills and low levels of education, (Lasley *et al.,* 1993). Dairy goat farming can be started by poor subsistence households with limited sources of incomes and can give them an opportunity to access daily milk requirements (Riethmuller, 2003). Those households which are financially endowed have an ability to increase their dairy goat stock and thus improve the production. Households that are financially constrained can boost their dairy goat stock through accessing loans. According to (Diagne and Zeller 2001) poor rural households in developing countries lack adequate access to credit which in turn impinges on significant negative impact on technology adoption, agricultural productivity, nutrition, health, and overall household welfare. Though credit facilities are not readily available for the willing farmers, most of the farmers within the study area have a long-standing history of low opinion to loans. According to (Mamudu *et al*., 2012) lack of access to credit makes it difficult for farmers to afford capital-intensive technologies while according to (Wakhungu *et al*., 2007), co-operative concept allows dairy farmers to benefit from farm inputs, credit or market of the milk produce.

Land is the most common asset among rural population and therefore good if properly used it can help in poverty reduction (Ravallion, 1989). Land tenure system and farm holding sizes are critical to land utilization and a key determinant to enterprise selection. Increase in human population and diminishing land sizes, has constrained farmers willing to keep large ruminants (Ahuya *et al.,* 2009). Semi-arid areas which have big farm sizes than sub humid zones are less potential and so farmers must properly set the production goals and objectives to achieve their targets. For dairy goat farmers who have land constraints, their production goal is to properly utilize their land for maximum returns.

Some of these farmers have therefore organized themselves into self-help groups that facilitate easy access to credits and subsidized prices to feeds, drugs and other inputs.

2.5 The role of dairy goat keeping on rural livelihoods

The main products from dairy goat farming includes; income from sales of products like milk, meat, skins, culls, manure and breeding material. It may also include intangible benefits such as improved soil fertility, improved nutrition, and dowry settlement. This income is used for the various household needs such as payment of school fees, purchase of food, clothing and medicine among others (Delgado *et al.,* 1999). Goat products such as milk, meat and cheese are important for nutritional improvement among the children and the old and even for the whole family (Anon, 2010). Crop and pasture production can also be enhanced by improved soil fertility from the farm yard manure realized from goat keeping. The main purpose for keeping dairy goats in the rural areas is to promote community development, food security, poverty reduction and crime prevention (Peacock, 1996).

Goats provide both tangible and intangible benefits to the farmers. Tangible benefits include, cash income from animal, milk and meat sales and for home consumption while intangible benefits include savings, an insurance against emergencies, dowry payment, buck service, cultural and ceremonial purposes (Kosgey *et al.,* 2006). Goats are hardy and can survive difficult periods. They are easy to keep in comparison to other livestock species and have good market demand (Call, 1981). They have the potential for improving the diet of the rural population and supplementing the producer's income (Roets, 1998). Even though goat keeping "causes environmental degradation", there are positive attributes to environmental conservation since its husbandry approach involves controlled grazing and sensitizing farmers to establish and conserve fodder trees such as *Calliandra species* and *Leuceana leucocephala* which improves soil fertility, check soil erosion and conserve water (Ahuya *et al*., 2009).

2.5.1 Improvement of income levels

Increased levels of dairy goat milk production above the average household consumption levels directly translates to increased income through sale of the surplus milk. According to (Gihad and El-Bedawy, 2000) keeping goats lowered financial risks and overcame periods of cash shortage. Goat farming in rural areas of India plays a vital role in providing gainful employment to the economically backward communities and resource poor farmers (Acharya, 1982). Goats are a viable option in improving the household cash flow of rural people and assisting in resolving the issue of food security (Kooster, 1986). Milk products like, cheese and yoghurt also provide households with income. Households with high quality dairy goats are more food secure as they can realize high dairy goat milk yields translating to more surplus milk.

In areas where dairy goat farming is highly practiced, there is improved sources of income through sell of breeding material and employment creation especially in milk processing plants, transportation of the milk and in the feed processing industries. The income can pay taxes, hospital bills and medicine, school fees, clothing, payment of credit and purchase of food items in crop failure thus contributing positively to the living standards of the community (Shirima, 2005; FAOSTAT, 2010). According to (Kosgey *et al.*, 2008) income raised from dairy goat farming in Kenya, can be used as fees (32%) purchase of food (22%), farm investment (18%), medical expenses (10%), off-farm investment (9%), social activities (5%) and restocking (4%). Farmers had a tendency of rearing dairy goats for generation of savings, as a security against emergencies requiring quick cash, and or asset protection.

2.5.2 Improvement of nutritional levels

Goat milk greatly improves the diet of many rural families because it is rich in basic food nutrients. In 2013, 60.3% of the dairy goat smallholder households in Kenya consumed goat milk indicating an increasing value of the dairy goat milk in their diet (Shivairo *et al.,* 2013). Goats supply precious animal proteins of high biological value in the form of

meat, milk, plus essential minerals and fat- borne vitamins to poor people, pregnant mothers and young children (Acharya, 1982 and Anon, 2010). Goat milk is produced for both home consumption and for sell to hospitals, hotels and other households without goats (MOLD, 2006). Goat milk also contributes to reduction of malnutrition among the vulnerable groups and it is traditionally valued for the elderly, the sick, babies, children who are allergic to cow milk, and patients with ulcers. Goat milk is more preferred to cow milk due to high percentage of solids, capable of improving human fertility and reducing effects of HIV/AIDS as reported by farmers (Gurmesa *et al*., 2011). Nutritionally goat milk contains fat, protein, lactose, Ca, P, Fe, Vitamins A and B complex (Table 2.1). Goat milk contains a higher proportion of short and medium chain fatty acids with smaller globules than cow milk; this makes goat milk promising in relieving stress and constipation (Farnworth 2011 and Ozung *et al*., 2011). It also contains higher medicinal value (curing people with migraine and asthma), vitamin B content and has higher digestibility (Ochepo and Momoh, 2010) than cow milk. According to (Haenlein, 1988), goat milk is associated with alleviating or controlling some diseases categorized into 3 groups, gastrointestinal (vomiting, diarrhoea, abdominal discomfort, colic and constipation), respiratory (asthma and bronchitis) and dermatological (eczema, dermatitis and rashes).

Table 2.1: Nutritive value of goat milk versus cow milk

COMPOSITIONS (Per 100 grams)	GOAT	COW
Protein (g)	3.1	3.2
Fat % (g)	3.5	3.9
Calories/100 ml	60	66
Vitamin A (IU/gram fat)	39	21
Vitamin B1(thiamin (UG/100/ml)	68	45
Riboflavin (ug/100 ml)	210	159
Vitamin C (mg ascorbic acid/100 ml)	2	2
Vitamin D (IU/gram fat)	0.7	0.7
Calcium %	0.19	0.18
Iron %	0.07	0.06
Phosphorus %	0.27	0.23
Cholesterol (mg/100 ml)	10	14
Sugars (lactose)	4.4	4.8
Saturated fatty acids (g)	2.3	2.4
Monounsaturated fatty acids (g)	0.8	1.1
Polyunsaturated fatty acids (g)	0.1	0.1

Source: Ozung *et al*., 2011

2.5.3 Soil fertility improvement

Fecal waste from goats has a lot of benefits to the environment since it is used in improving soil fertility to farms especially for farmers with small parcels of land. The manure from goats is highly recommended since goats are browsers which do selective feeding on highly palatable plant species. Goats being browsers feed on a variety of plant species and as a result, their dropping is good in soil fertilization and improves crop yields since it has a lot of nutrients compared to another animal (Delgado *et al.*, 1999). According to (Osuhor *et al.* 2002) Red Sokoto goat manure contain 2.81%, N 0.42%, P 0.93 K. Similarly (Lamidi *et al.* 2007) reported that faecal droppings by un supplemented Bunaji cattle contains 1.79% N, 0.46% P, and 0.93% K and that of supplemented cattle contain 2.27% N, 0.52% P and 0.74% K while that of sheep contain 2.18% N, 0.48% P and 0.52% K. In Kenya, NPK are the major nutrient in commercial fertilizer. Livestock manure also contains Fe, Mn, Zn and Cu etc (Kallah and Adamu, 1988.). Most of the farmers use the manure for their own farms to improve crop and pasture production. According to (Ogola *et al.,* 2010), 76.8% small scale farmers in rural areas of Kenya do not buy inorganic fertilizer, but used manure in their farms to increase crop yields. Though there has been a controversy that goats are destructive to trees, the efforts of dairy farmers to establish pastures and fodder for their goat's positive activities towards improvement of soil fertility since some of those fodder crops are leguminous and capable of facilitating soil nitrogen fixation. Likewise (Onim, 1992) observed that manure from goats had a positive environmental effect when used on either crop land or fodder. In systems where farmers cut and carry forage for their goats, the manure is easily collected and spread to the fields (Juma and Pica-Ciamarra, 2013).

2.6 Theoretical frame work

This study adopted Rogers Innovation adoption theory (Rodgers, 1995) as shown in figure 2.6. In the theory, the adoption process begins when a person moves from a state of ignorance i.e. being unaware or ignorant, to being aware. Rejection may follow immediately or the adoption decision-making process may continue and the individual

will develop and consequently demonstrate an interest in the innovation. Rejection may follow, or the individual may proceed into the next stage of the adoption decision-making process, comparison (see figure 2.6). During this stage, the individual will compare the innovation with what is current. Rejection may result. If the comparison is favorable, the next phase is to test the innovation. During this stage the person will want to test the innovation on small scale, to see if it works for them. The adoption process will be influenced by interaction of various factors such as policy, socio cultural and economic contexts, and climate among others.

Through proper understanding of all factors that influence adoption of a particular technology, the extensionist can predict and account for the factors that impede or facilitate the diffusion of the technology. Diffusion occurs over time and has five stages, i.e knowledge, persuasion, decision, implementation, and confirmation. According to this theory, potential adopters of an innovation must learn about the innovation, be persuaded by extensionist (in case of agricultural technologies) to the merits of the innovation, decide to adopt, implement the innovation, and confirm (reaffirm or reject) the decision to adopt the innovation. In this study, environmental factors, socio economic factors and adoption of dairy goat management technologies will determine the levels of milk production by dairy goats in Kyangwithya east and west wards of Kitui central sub-County.

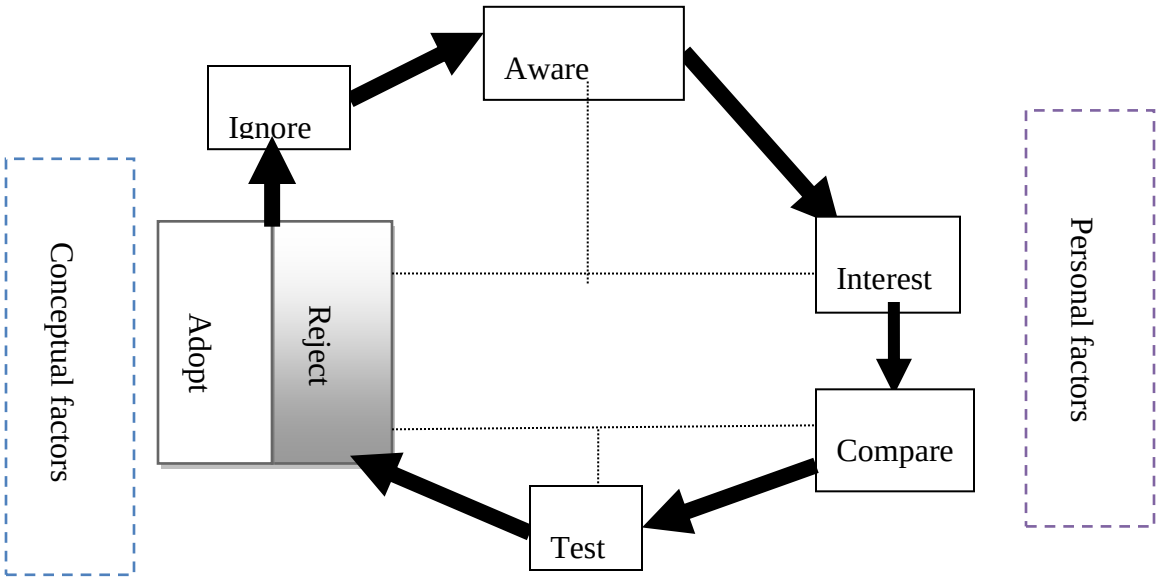

Figure 2.6 Theoretical frame work

2.7 Conceptual framework

Dairy goat milk production improves the living standards of the people within the study area. This is through increased milk production for household consumption thereby improving the nutritional status. Increased income is realized through sell of the surplus milk and breeding stock to other farmers. The increased income can cater for food, educate children, and pay for drugs and hospital bills among others. These are notable indicators of improved living standards.

Climatic factors such as rainfall, temperature and humidity impact directly on pasture and fodder production which is a major contributor to milk production. Disease and pest incidences also have a direct effect on milk production since they can have influence on the individual animal. Climatic factors and socio-economic factors such as farm holdings, household income, availability and access of credit facilities are independent variables. Management factors which include animal housing, disease control, feeding, watering, breeding and culture on the utilization of dairy goat milk are control variables. Both independent and control variables influence dairy goat milk production, which is the dependent variable.

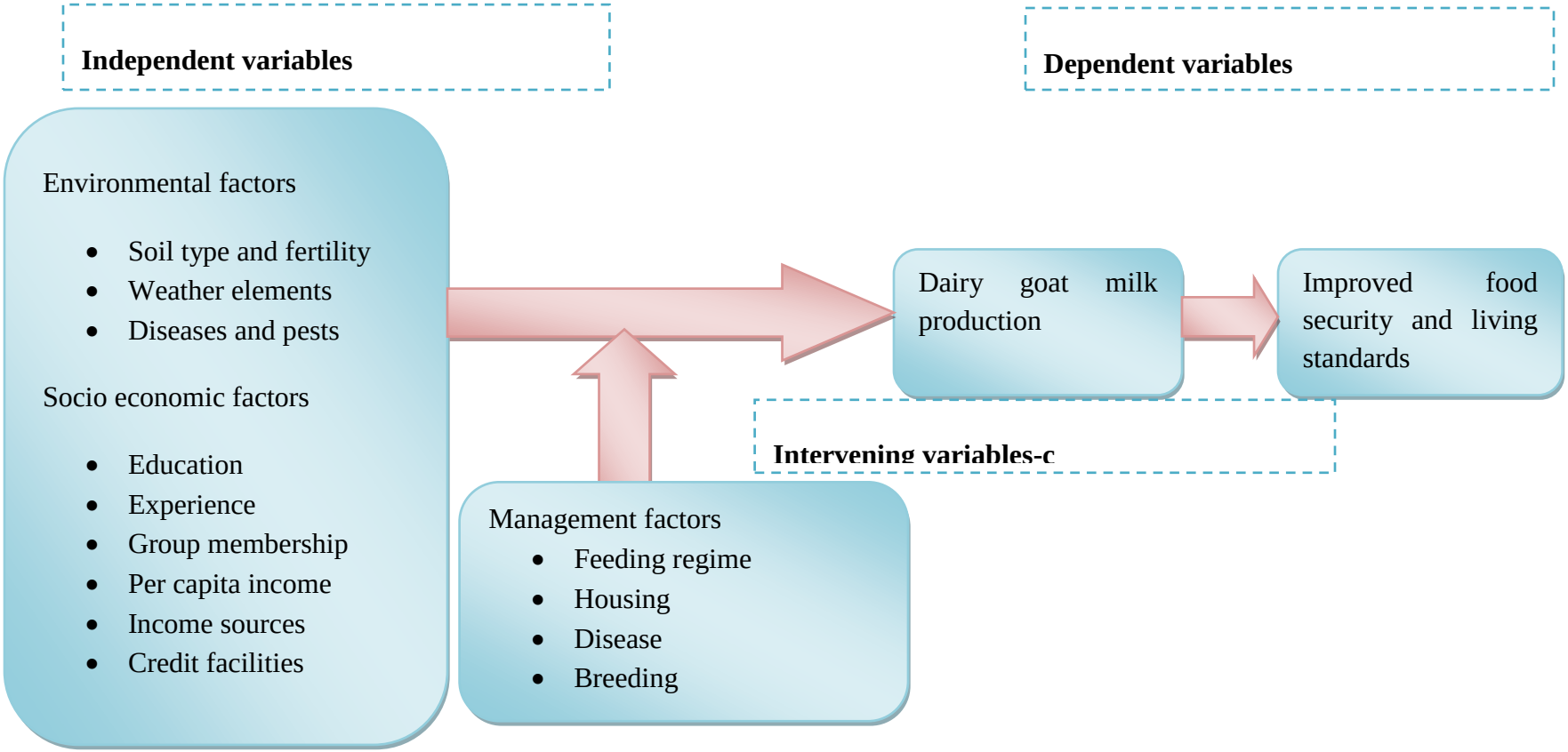

Figure 2.7 conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Study Location

Kitui County has an area of 30,496.5 km^2 with an estimated population of 1,012,709. It is made up of eight (8) sub-counties divided into 40 electoral wards. The sub counties are Kitui Central (5 wards), Kitui West (4 wards), Kitui East (6 wards), Kitui South (6 wards), Kitui Rural (4 wards), Mwingi North (5 wards), Mwingi Central (6 wards) and Mwingi West (4 wards). It is further divided into 152 locations and 404 sub locations.

The county is primarily a livestock rearing area, where livestock enterprises are a major source of livelihood. The main livestock breeds kept are cattle (Zebu, Boran, Sahiwal, Friesian and Aryshire), Goat (East African, Galla, Alpine and Toggenburg) and sheep (Black headed Persian, and Red Masai). Poultry and bee keeping are already in existence in the area. The county is an arid and semi-arid with some portions having sub humid to humid climate especially along the hills. Some of the sub counties cut along the two zones thus experiencing both arid conditions and sub humid conditions. These sub counties are Kitui Central, Kitui West and Mwingi West. Farmers within these three sub counties have dairy goats which they might have acquired through their own initiatives or through development projects. The common goats kept within the study area were exotic goats (Alpines and Toggenburgs) and indigenous goats (Small east African goat and Galla).

The study looked at Kitui Township, Kyangwithya east and west wards of Kitui central sub county since it experiences both semi-arid conditions and sub humid condition and it had more concentration of dairy goats. The wards have 13 sub locations. The wards are located between latitudes 1°31' and 1°15' south and longitudes 37°58' and 38°7' east with an altitude ranging between 600 m and 1400 m above sea level and annual rainfall ranging between 500mm to 1200 mm per annum with 40% reliability for the long rains and 66% reliability for the short rains. The temperatures are high throughout the year,

range between 14°C to 34°C with hottest period between September to October, and January to February. The coldest month is July with temperatures falling to a 14°C while the hottest is month September with temperature rising to 34°C.

The wards have an area of 198.61 Km²and an estimated population of 66,772 people (32967 males and 33805 females) according to 2009 population Census with an average of 15806 households. Sampling was done in 9 sub locations of the wards where dairy goat farming was introduced by various development agents. These sub locations have an estimated area of 153.68 km^2 and a total population density of 4443.91 with 44822 people (22080 males and 22742 females) and 8112 households (2009 census).

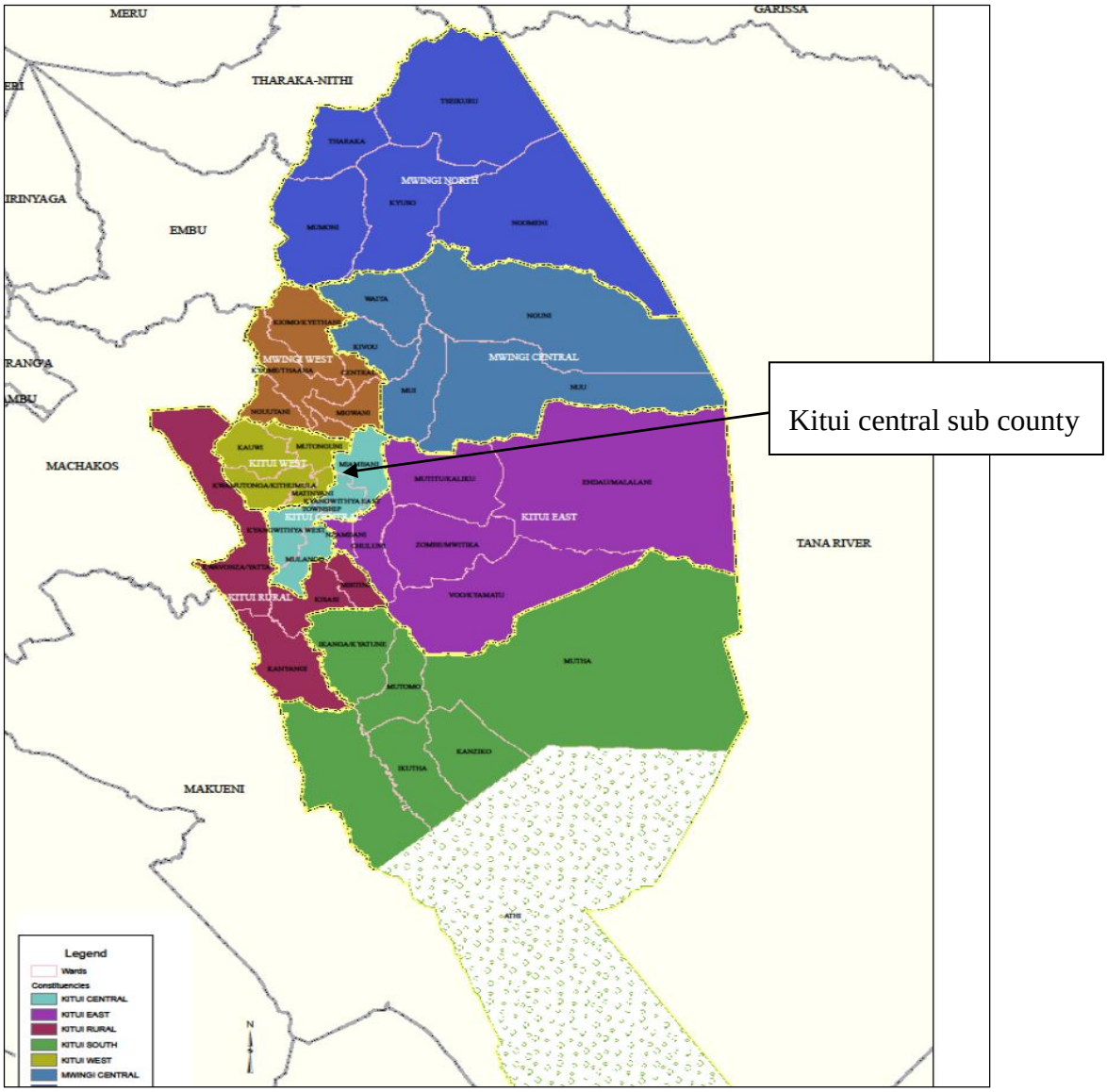

Figure 3.1: Map of the Kitui County by administrative units: Showing Kitui central sub county

Source: Kenya National Bureau of Statistics, 2013

Table 3.1 Rainfall and temperature data

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temp (°C)	21.8	22.7	23.1	22.5	21.7	20.1	19.3	19.5	21	22.2	22	21.4
Min. Temp (°C)	14.6	15.2	16	16	15.3	13.6	13	13	13.4	14.9	15.7	15
Max. Temp (°C)	29	30.3	30.3	29.1	28.1	26.6	25.6	26.1	28.6	29.6	28.4	27.8
Precipitation / Rainfall (mm)	38	39	144	232	47	6	2	7	9	87	330	127

https://en.climate-data.org/location/11147/Kitui

Between the driest and wettest months, the difference in precipitation is 328 mm. The variation in temperatures throughout the year is 3.8 °C.

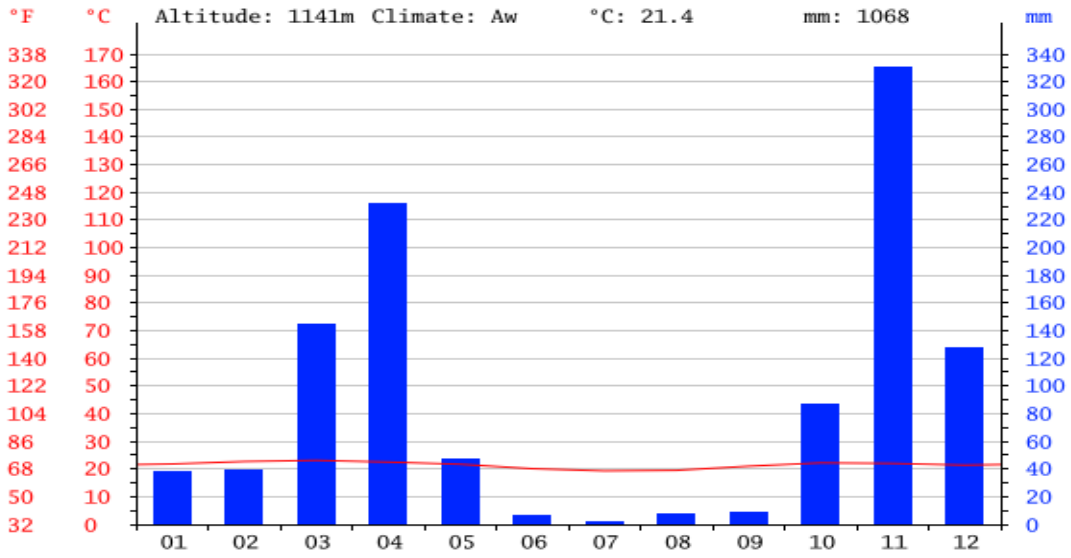

Figure 3.2 Rainfall data

https://en.climate-data.org/location/11147/Kitui

Precipitation is the lowest in July, with an average of 2 mm. The greatest amount of precipitation occurs in November, with an average of 330 mm.

3.2 Target Population

The target population of study was dairy goat farmers within the sub humid and semi-arid agro ecological zone of Kitui Township, Kyangwithya east and Kyangwithya west of Kitui Central Sub County. Only those households keeping dairy goats were identified. The nine (9) sub locations where the study was carried are Mulundi, Mulutu, Kaveta, Museve, Mbusyani, Mutune, Misewani, Kalundu and Tungutu where intervention was initiated by Kitui Agricultural Project (KAP), Farm Africa, Arid Lands Resource Management project (ALRMPII), Catholic diocese of Kitui (CDK), and Kitui Development Centre (KDC).

3.3 Sample size

The population of the study area was 44822 persons (GOK, 2009) comprising of approximately 8112 households. Sample size was obtained from purposively sampled sub locations within Kitui central sub county where different development programs supported some households with dairy goats assuming 95% confidence interval (α)and 80% statistical power (β) (Magnani, 1997).

$$\mathbf{n = D\ [(Z_\alpha + Z_\beta)^2\ X\ (P_1\ (1 - P_1) + P_2\ (1 - P_2))\ /(P_2 - P_1)2]}$$

$$n = 2[(1.645 + 0.840)^2\ X\ (0.45(1- 0.45) +0.7(1- 0.7)\ /\ (0.7 - 0.45)^2$$

$$n = 2[6.175\ X\ 0.2475 +0.21\ /0.0625]$$

$$n = 2[2.8250625\ /\ 0.0625]$$

$$n = 90.402$$

A sample size of 90 was therefore used

Where:

n = Sample size

D = Design effect (assumed to be the *default* value of 2)

P_1 = Estimated proportion level of an indicator at the first time of the survey

(45% was used)

P_2 = *Expected* proportion level of the indicator at some future date such that the quantity (P_2 - P_1) is the size of the magnitude of change it is desire to be able to detect (25% was used as $P_2 – P_1$, so P_2 was 70%)

Z_α = α - statistical significance 95% was used (which is has a value of 1.645)

Z_β = β - statistical power, 80% was used (which has a value of 0.840)

N/B:

$Z\alpha$ = Is the Z-score corresponding to the degree of confidence with which it is desired to be able to conclude that an observed change of size (P_2 - P_1) would not have occurred by chance

Z_β = is the Z-score corresponding to the degree of confidence with which it is desired to be certain of detecting a change of size (P_2 - P_1) if one actually occurred

Statistical significance (α): Guards against falsely concluding that a change has occurred

Statistical power (β): Guards against a false conclusion that nothing has happened as a result of a program

3.4 Sampling design and techniques

Multi stage sampling procedure which involved, purposive sampling, stratified sampling and systematic random sampling techniques as described by (Bryman, 2001) were used to select the respondents. The first stage involved stratified sampling of the eight sub counties of Kitui County based on their agro ecological zone (AEZ) and picking those that had both semi-arid and sub humid conditions. These were Kitui central, Kitui west and Mwingi west. Purposive sampling done to find which sub locations in which sub county had highest concentration of dairy goats and Kitui where different development programs supported some households with dairy goats. Nine sub locations in Kitui Township, Kyangwithya east and west wards of Kitui central sub county were arrived at. Four sub locations in sub humid area (Museve, Mulundi, Mutune, and Misewani) with a total population of 23770 people and 4214 households and five sub locations in semi-arid area (Kaveta, Kalundu, Tungutu, Mbusyani and Mulutu) with a total population of 21052 people and 3898 households were identified from 13 sub locations of the wards. Systematic random sampling of a sample frame of 4214 households within the four sub locations of sub humid area was conducted to get 45 households keeping dairy goats. Similarly, systematic random sampling of a sample frame of 3898 households within the

five sub locations in semi-arid area was done to get 45 households keeping dairy goats. In case a selected household was found not to be keeping dairy goats, the next household was selected. A total of 90 households were selected as described by (Magnani, 1997), and interviewed using semi structured questionnaires.

3.5 Data collection

Both primary and secondary data was collected. Field surveys using both closed ended and open-ended questionnaires were done during interview schedules to collect primary data from the systematically selected households. The data collected was on household characteristics, the environmental, management and, socio economic factors influencing dairy goat milk production and the role of dairy goat keeping in the livelihoods of households. The households included farmers keeping exotic goats (Alpines and Toggenburgs), cross breeds and indigenous goats (local and Galla). During the interview, the first session involved building confidence with the respondents so that they can participate fully and without reservation. Secondary data was collected from county and national government ministries and departments. Ministry of lands and Housing availed the map of the area; Livestock department provided information on exotic and indigenous goat breeds, numbers and their distribution while the Kenya National Bureau of Statistics provided data on households' information within the study area.

3.6 Data analysis

Statistical package for social sciences (SPSS) was used to analyze the data. The study analyzed data on environmental and management factors affecting milk production of both exotic and indigenous goats within the study area. The data on socio economic factors affecting milk production and the role played by dairy goat farming towards improvement of rural livelihood within the study area was also analyzed. The relationship between dependent and independent variables was analyzed. The dependent variable for this study was milk production levels, which depended on the type of breed, environmental factors (rainfall, temperatures and land sizes) and socio-economic factors

(income levels, literacy levels, management abilities, group affiliation, access to credits, culture and gender bias).

3.6.1 Descriptive Statistics

Descriptive statistics was used to analyse the data on household characteristics, management and socio-economic factors influencing milk production by different goats and the role played by goat keeping towards improvement of rural livelihood. A chi-square test was done to determine whether each of the factors had statistical difference in levels of milk production across the breeds. Descriptive analysis provides guidance for more advanced quantitative analyses.

3.6.2 Crosstabs Chi-Square Tests

The crosstabs chi-square test was used to measure the level of association among categorical variables. Variables which are statistically significant are considered associated, while those which are insignificant are not associated.

3.6.3 Regression Analysis

The regression analyses were done to address the inadequacy of descriptive analyses in showing how environmental factors affect goat milk production levels. Regression statistics tackle the direction and magnitude of the variables that influences the dependent variable. The logistic model helped to determine the factors that influenced goat milk production levels within the study area. The regression analysis involved studying the prediction of outcome/dependent variable (milk production) from a set of several predictor/independent variables.

3.6.4 Description of Analytical Model

Regression statistics was used to show the effects in terms of direction and magnitude of each of the variables to the dependent variable.

The linear regression model is an analytical model in which the outcome variable (Y_i) is predicted from a combination of each predictor variable (X_i) multiplied by its respective regression coefficient (β_i). This regression model can be summarized as: $Y_i = \beta_0 + \beta_1 (x_1)i + \beta_2 (x_2)i + \beta_3 (x_3)i + \ldots + \beta_K (x_K)i + \varepsilon i$ (i) Where: Y_i = Variable. Y_i is designated as the "dependent variable." X_1, X_2 ……., X_K are predictor / explanatory variables used in the model. β_0= Constant value of the model for different variable.

β_1, β_2……. β_K are coefficients of the variables, X_1, X_2 ……, X_K used for each dependent variable in the model. In this model, the coefficients (β"s) are non-random values but of unknown quantities. The noise terms ε_1, ε_2, ε_3, …, ε_n are random and unobserved and it is further assumed that these ε"s is statistically independent, each with mean 0 and (unknown) standard deviation σ (Field, 2006). Therefore, the fitted multiple regression model was: $Y_i = \beta_0 + \beta_1 (x_1)_i + \beta_2 (x_2)i + \beta_3 (x_3)i + \ldots\ldots\ldots\ldots\ldots.. + \beta_K (x_K)i$

The following data sets were fed to the regression model and used for analysis.

Data: Prediction factors influencing milk production levels of different goats (exotic and indigenous):

$Y= \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon$

Where Y= Milk production levels of different goats (exotic and indigenous)

β_0 = Constant factor

X_1 = March to May rains {1 =low, 2 = high} [low = <750mm/year, high = <750mm/year]

X_2 = October to December rains {1 =low, 2 =high}

X_3= Daily temperatures {1 = low, 2 = high} [low = $>20c^0$, high = $<20c^0$]

X_4 = Fertility of farm soils {1 = low, 2 = high} [low = use fertilizer/ manure, high = don't use fertilizer/manure]

X_5 = Utilization of feacal waste {1 = used in farm, 2 = Not used in farm}

X_6 = Farm sizes {1 = <2 acres, 2 = > 2acres}

X_7 = Type of pasture/ fodder {1 = pasture grasses, 2 = fodder legumes}

X_8 = Type of grazing {1 = intensive, 2 = extensive}

X_9 = Frequency of feed supplementation {1 = frequent, 2 = not frequent}

X_{10} = Time of supplementation {1 = pregnant or milking, 2 = every time}

X_{11} = Type of feed supplements {1 = commercial rations, 2 = homemade rations}

X_{12} = Frequency of watering {1= daily, 2 = alternate days}

X_{13} = Sources of water {1 = piped/ borehole, 2 = shallow well/riverbed wells}

X_{14} = Distances watering points {1 = <0.5km, 2 = >0.5km}

X_{15} = Type of goat housing {1= local, 2= improved}

X_{16} = Frequency of goat housing {1 = frequent, 2 = not frequent}

X_{17} = Frequency of house cleaning {1 = clean once per week, 2 = clean twice per week}

X_{18} = Frequency of common diseases and pests {1 = frequent, 2 = not frequent}

X_{19} = Frequency of vaccination {1 = none, 2 = as recommended}

X_{20} = Frequency of spraying/ dipping {1 = none, 2 = as recommended}

X_{21}= Frequency of deworming {1 = none, 2 = as recommended}

X_{22} = Frequency of inbreeding {1 = frequent, 2 = not frequent}

X_{23} = Frequency of use of castration {1 = frequent, 2 = not frequent}

X_{24} = Frequency of culling/upgrading {1 = frequent, 2 = not frequent}

X_{25} = Frequency of buck exchange {1 = frequent, 2 = not frequent}

X_{26} = Frequency of buck rotation {1 = frequent, 2 = not frequent}

X_{27}= Education level of household head {1 = primary, 2 = above primary}

X_{28} = Experience of household head {1 = < 5 years,2 = > 5 years}

X_{29} = Affiliation to self-help group {1 =yes, 2 = no}

X_{30} = Household per capita income {1 = <Ksh 15000, 2 = > Ksh 15000}

X_{31} = Overall household income sources {1 farming, 2 = other sources}

X_{32} = Presence of credit facilities {1 = yes, 2 = no}

X_{33} =Accessibility of credit facilities {1 = yes, 2 = no}

β_i = coefficient

ε = error term

CHAPTER FOUR

RESULTS

4.1 Demographic characteristics of respondents

Analysis using cross tab chi square revealed that there were more male headed households (80%) at ($\chi^2 = 5.760$ p = 0.016) in sub humid areas than in the semi-arid areas (Table 4.1). Females headed households were higher in the semi-arid zone (44%) compared to the sub-humid zone. There were also more farmers aged above 50 years (62.5% and 84%) at ($\chi^2 = 5.399$ p = 0.020) in both sub humid and semi-arid zone respectively. Similarly, there were more married farmers than single farmers at ($\chi^2 = 6.095$ p = 0.014) with 92.5% and 72% being in sub humid and semi-arid areas respectively.

The level of education had significant effects to milk production at ($\chi^2 = 14.250$ p = 0.000) with 70% of the respondents in sub humid area having above primary education. Affiliation to self-help groups had effects to milk production levels at ($\chi^2 = 60.506$ p = 0.000) with farmers (87.5 %) in sub humid areas being members of groups compared to only 6% in semi-arid areas. Similarly, experience in dairy goat keeping had effects to milk production levels at ($\chi^2 = 8.372$ p = 0.004) with 72.5% of farmers in sub humid areas having more experience in dairy goat keeping. On household flock sizes, the number of exotic goats kept by households in sub humid areas higher at (72.5%) than those in semi-arid areas however, the number of indigenous goats kept in semi-arid areas were higher (90%) compared to those in sub humid areas. 72.5% of farmers in sub humid areas keeping more than 3 exotic goats similar to 74% of those keeping indigenous goats in in semi-arid areas.

Toggenburg was most preferred type of exotic goat with 75% of farmers in sub humid zone and 64% in semi-arid areas keeping it. However, Small east African goats were more preferred by farmers in semi-arid zone (68%) in contrast to Galla goats (67.5%) in sub humid areas. Livestock sales and petty trade were the main sources of income with

87.5 % and 62.5% of farmers in sub humid earning their income from livestock sales and petty trade respectively similar to 86% and 46 % respectively in semi-arid areas.

Table 4.1 Household characteristics

Characteristic		**sub humid**	**semi-arid**	χ^2	**p - value**
Gender of household head %	Male	80.0	56.0	5.760	0.016*
	Female	20.0	44.0		
Age of household head %	30-49	37.5	16.0	5.399	0.020*
	>50	62.5	84.0		
Size of households (%)	<5 members	60.0	64.0	0.151	0.697
	>5 members	40.0	36.0		
Marital status %	Single/divorced	7.5	28.0	6.095	0.014*
	Married	92.5	72		
Education of household heads (%)	Primary	30	70	14.250	0.000*
	Above primary	70	30		
Experience in goat keeping (%)	<5 years	27.5	58	8.372	0.004*
	>5 years	72.5	42		
Group membership (%)	Member	87.5	6	60.506	0.000*
	Non-member	12.5	94		
Number of	< 3	27.5	90	36.929	0.000*

household's Exotic goats %	>3	72.5	10		
Number of household's indigenous goats %	< 3	72.5	26	19.306	0.000*
	>3	27.5	74		
Type of exotic goat kept %	Alpine	25	36	1.255	0.263
	Toggenburg	75	64		
Type of indigenous goat kept %	S.E.A.G	32.5	68	11.224	0.001*
	Galla	67.5	32		
Sources of household income %	Employment	27.5	16	1.765	0.184
	None	72.5	84		
	Pension	12.5	4	2.238	0.135
	None	87.5	96		
	Livestock sales	87.5	86	0.043	0.835
	None	12.5	14		
	Petty trade	62.5	46	2.431	0.119
	None	37.5	54		
	Casual labour	15	8	1.0103	0.294
	None	85	92		
	Remittances	7.5	2	1.583	0.208

	None	92.5	98		

***Significant at (p<0.05)**

Table 4.2(a) showed the overall regression model for all independent variables influencing the dependent variables (milk production levels of exotic goats).

Table 4.2(a) Factors affecting exotic goat milk production levels

Model		**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
Independent variables	(Constant)	0.472	0.338		1.396	0.168
	Level of education	-.011	0.032	-0.011	-0.346	0.730
	Monthly household income	0.005	0.025	0.004	0.194	0.847
	Household income sources	0.013	.023	0.013	0.572	0.570
	Experience in goat keeping	0.022	0.023	0.022	0.935	0.354
	Amount of March-May rains	0.084	0.067	0.083	1.248	0.217
	Amount of October - December rains	0.102	0.041	0.102	2.478	0.016
	Daily temperatures	-0.031	0.024	-0.030	-1.297	0.200

	Level of soil fertility	-0.010	0.046	-0.010	-0.213	0.832
	Farm sizes	0.012	0.020	0.011	0.576	0.567
	Utilization of livestock faecal waste	0.008	0.043	0.008	0.174	0.862
	Type of pastures/fodder	0.008	0.032	0.007	0.238	0.813
	Type of grazing system	0.003	0.023	0.003	0.151	0.881
	Frequency of feed supplementation	-0.019	0.038	-0.018	-0.490	0.626
	Time of feed supplementation	-0.006	0.033	-0.006	-0.189	0.851
	Type of feed supplement	0.018	0.021	0.018	0.849	0.400
	Frequency of goat watering	0.025	0.025	0.025	0.990	0.327
	Sources of waters	-0.025	0.023	-0.026	-1.122	0.267
	Distances to the watering point	-0.002	0.036	-0.002	-0.065	0.948
	Goat housing	-0.032	0.027	-0.032	-1.176	0.244
	Type of goat house	-0.012	0.020	-0.012	-0.609	0.545

	Frequency of goat house cleaning	0.011	0.025	0.011	0.427	0.671
	Frequency of common diseases and pests	0.065	0.039	0.064	1.676	0.099
	Frequency of goat vaccination	-0.005	0.028	-0.005	-0.184	0.855
	Frequency of goat spraying/dipping	0.437	0.066	0.435	6.586	0.000
	Frequency of goat drenching	0.187	0.081	0.186	2.306	0.025
	Membership to self-help group	-0.021	0.032	-0.021	-0.660	0.512
	Frequency of inbreeding	0.000	0.022	0.000	-0.013	0.990
	Castration as control of inbreeding	0.069	0.060	0.068	1.157	0.252
	Culling as control of inbreeding	0.007	0.033	0.006	0.221	0.826
	buck exchange as control of inbreeding	-0.085	0.064	-0.085	-1.328	0.190
	Buck rotation as control of inbreeding	-0.082	0.057	-0.078	-1.435	0.157

	Selection as up grading tool	-0.001	0.029	-0.001	-0.022	0.982
	Presence of credit facilities	-0.006	0.026	-0.005	-0.232	0.818
	Accessibility of credit	-0.026	0.035	-0.022	-0.740	0.462
Dependent Variable: Milk production levels in exotic goats						

***Significant at (p<0.05)**

Similarly, table 4.2(b) shows the overall regression model for all independent variables influencing the dependent variables (milk production levels of indigenous goats).

Table 4.2(b) Factors affecting indigenous goat milk production levels

Model		**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
Independent variables	(Constant)	0.284	0.553		0.514	0.609
	Level of education	-0.024	0.053	-0.024	-0.453	0.653
	Monthly household income	0.004	0.041	0.003	0.088	0.930
	Household income sources	0.026	0.038	0.025	0.696	0.490
	Experience in goat keeping	0.019	.038	0.019	0.502	0.618

	Amount of March-May rains	0.088	0.110	0.088	0.798	0.428
	Amount of October - December rains	-0.046	0.067	-0.047	-0.685	0.496
	Daily temperatures	0.068	0.039	0.067	1.746	0.086
	Level of soil fertility	-0.017	0.074	-0.017	-0.223	0.824
	Farm sizes	0.024	0.033	0.023	0.713	0.479
	Utilization of livestock faecal waste	0.022	0.070	0.022	0.313	0.755
	Type of pastures/fodder	0.012	0.053	0.012	0.235	0.815
	Type of grazing system	-0.024	0.037	-0.024	-0.638	0.526
	Frequency of feed supplementation	-0.013	0.062	-0.012	-0.206	0.837
	Time of feed supplementation	-0.081	0.053	-0.083	-1.530	0.132
	Type of feed supplement	0.010	0.034	0.010	0.299	0.766
	Frequency of goat watering	-0.052	0.041	-0.053	-1.273	0.208
	Sources of waters	-0.044	0.037	-0.045	-1.191	0.239

	Distances to the watering point	-0.082	0.058	-0.083	-1.412	0.164
	Goat housing	-0.024	0.045	-0.024	-0.536	0.594
	Type of goat house	0.012	0.032	0.013	0.391	0.698
	Frequency of goat house cleaning	-0.089	0.040	-0.090	-2.208	0.031
	Frequency of common diseases and pests	0.215	0.063	0.216	3.410	0.001
	Frequency of goat vaccination	0.082	0.046	0.081	1.800	0.077
	Frequency of goat spraying/dipping	0.767	0.108	0.773	7.080	0.000
	Frequency of goat drenching	-0.094	0.133	-0.094	-0.706	0.483
	Membership to self-help group	0.005	0.053	0.005	0.096	0.924
	Frequency of inbreeding	-.025	0.036	-0.024	-0.688	0.494
	Castration as control of inbreeding	-0.071	0.097	-0.070	-0.724	0.472
	Culling as control of inbreeding	-0.087	0.053	-0.074	-1.629	0.109

	buck exchange as control of inbreeding	0.208	0.105	0.210	1.990	0.052
	Buck rotation as control of inbreeding	0.089	0.093	0.087	0.963	0.340
	Selection as up grading tool	.004	.047	.003	.079	0.937
	Presence of credit facilities	-0.036	0.042	-0.033	-0.868	0.389
	Accessibility of credit	-0.079	0.057	-0.069	-1.383	0.172
Dependent Variable: Milk production levels in indigenous goats						

***Significant at (p<0.05)**

4.2 Factors affecting milk production levels of different goat breeds

4.2.1 Environmental factors affecting exotic goat milk production levels

Descriptive statistics analysis of environmental factors using cross tabs chi square revealed that there was a significant association between the rainfall (short and long rains), temperatures, levels of soil fertility and utilization of feacal waste with the milk production levels from exotic goats at ($\chi^2 = 78.462$ p = 0.000*, $\chi^2 = 70.772$ p = 0.000*, $\chi^2 = 11.553$ p = 0.001*, $\chi^2 = 6.654$ p = 0.01* and $\chi^2 = 5.885$ p = 0.015*) since those who said the rainfall amounts were high, and utilized livestock fecal waste in their farms reported more milk production levels. The size of farms had no association to milk production levels (Table 4.2.1.1). This analysis did not show the magnitude of association hence regression analysis was used.

Table 4.2.1.1 Environmental factors affecting exotic goat milk production levels

Environmental factor		**Milk production levels in exotic goats**		χ^2	**p**
		< 2 litres	**>2 litres**		
March to May rains (%)	low	94.4	5.6	78.462	0.000*
	high	0.0	100		
October to December rains (%)	low	94.2	5.8	70.772	0.000*
	high	5.3	94.7		
Daily temperatures (%)	low	33.3	66.7	11.553	0.001*
	high	70.2	29.8		
Levels of soil fertility (%)	low	67.9	32.1	6.654	0.01*
	high	40.5	59.5		
Farm sizes (%)	<2 acres	54.4	45.6	0.329	0.566
	>2acres	60.6	39.4		
Utilization of livestock feacal waste (%)	Used in farm	42.5	57.5	5.885	0.015*
	Not used in farm	68	32		

***Significant at (p<0.05)**

Analysis using linear regression revealed that holding all other independent variables constant at zero, a unit increase in March to May rains, October to December rains, farm

sizes and utilization of livestock feacal waste caused a 0.084, 0.102, 0.012 and 0.008 increases in milk production levels by exotic goats however a unit increases in daily temperatures and soil fertility levels caused a 0.031 and 0.010 decrease in milk production levels by exotic goats. This meant that increasing the amount of rainfall, farm sizes and use of feacal waste increased milk production levels of exotic goats. The October to December rains had more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.102. The October December rains were also significantly different from zero at $P<0.05$ since it had a P value of 0.016 and t value of 2.478 (Table 4.2.1.2).

Table 4.2.1.2a Environmental factors affecting exotic goat milk production levels

Environmental factor	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168
Amount of March- May rains	0.084	0.067	0.083	1.248	0.217
Amount of October - December rains	0.102	0.041	0.102	2.478	0.016*
Daily temperatures	-0.031	0.024	-0.030	-1.297	0.200
Level of soil fertility	-0.010	0.046	-0.010	-0.213	0.832
Farm sizes	0.012	0.020	0.011	0.576	0.567

Utilization of livestock faecal waste	0.008	0.043	0.008	0.174	0.862

Significant at (p<0.05) *

4.2.2 Environmental factors affecting indigenous goat milk production levels

Descriptive statistics analysis of environmental factors using cross tabs chi square revealed that there was a significant association between the rainfall (short and long rains), temperatures, levels of soil fertility and utilization of feacal waste with the milk production levels by indigenous goats at (χ^2 = 66.736 p = 0.000*, χ^2 = 60.129 p = 0.000*, χ^2 = 6.707 p = 0.01*, χ^2 = 5.171 p = 0.023* and χ^2 = 4.688 p = 0.030*) since those who said the rainfall amounts were high, and utilized livestock fecal waste in their farms reported more milk production levels. The size of farms had no association to milk production levels (Table 4.2.2.1). The analysis did not show the magnitude of association hence regression analysis was used.

Table 4.2.2.1 Environmental factors affecting indigenous goat milk production levels

Environmental factors		**Milk production levels in indigenous goats**		**χ^2**	**p**
		< 1 litres	**>1 litres**		
March to May rains (%)	low	94.4	5.6	66.736	0.000*
	high	8.3	91.7		
October to December rains (%)	low	94.2	5.8	60.129	0.000*
	high	13.2	86.8		
Daily temperatures (%)	low	42.4	37.6	6.707	0.01*
	high	70.2	29.8		

Levels of soil fertility (%)	low	69.8	30.2	5.171	0.023*
	high	45.9	54.1		
Farm sizes (%)	<2 acres	59.6	40.4	0.008	0.929
	>2acres	60.6	39.4		
Utilization of livestock feacal waste (%)	Used in farm	47.5	52.5	4.688	0.030*
	Not used in farm	60	40		

***Significant at (p<0.05)**

Analysis using multiple regression revealed that taking all other variables constant at zero, a unit increase in March to May rains, temperatures, farm sizes and utilization of livestock feacal waste caused a 0.088, 0.068, 0.024 and 0.022 increases in milk production levels by indigenous goats however a unit increases in October December rains and soil fertility levels caused a 0.046 and 0.017 decrease in milk production levels by indigenous goats. This meant that increasing the march may rains, farm sizes and use of feacal waste increased milk production levels of indigenous goats. The March to May rains had more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.088 (Table 4.2.1.2).

Table 4.2.1.2b Environmental factors affecting indigenous goat milk production levels

Environmental factors	**Un standardized Coefficients**	**Standardized Coefficients**	**t**	**Sig.**

	B	Std. Error	Beta		
(Constant)	0.284	0.553		0.514	0.609
Amount of March- May rains	0.088	0.110	0.088	0.798	0.428
Amount of October - December rains	-0.046	0.067	-0.047	-0.685	0.496
Daily temperatures	0.068	0.039	0.067	1.746	0.086
Level of soil fertility	-0.017	0.074	-0.017	-0.223	0.824
Farm sizes	0.024	0.033	0.023	0.713	0.479
Utilization of livestock faecal waste	0.022	0.070	0.022	0.313	0.755

4.3 Management factors affecting milk production levels of different goat breeds

4.3.1.1 Feeding in exotic goats

Descriptive statistics using cross tab chi square revealed that there was an association between level of milk production by exotic goats, type of pasture planted and the frequency of feed supplementation at ($\chi^2 = 21.679$ p = 0.000, and $\chi^2 = 32.719$ p = 0.000) respectively since over 59 % of respondents reported using fodder legumes and supplementing their goats frequently (Table 4.2.1.1a).

Table 4.3.1.1a feeding in exotic goats

Feeding in exotic goats	Milk production	χ^2	p

		levels in exotic goats			
		< 2 litres	>2 litres		
Type of pasture (%)	pasture grasses	92.9	7.1	21.679	0.000*
	Fodder legumes	40.3	59.7		
Type of grazing system (%)	Intensive	59.5	40.5	0.212	0.609
	Extensive	54.2	45.8		
Frequency of feed supplementation (%)	Frequent	36.1	63.9	32.719	0.001*
	Not frequent	100.0	0.0		
Time of feed supplementation (%)	Pregnant/milking	47.6	52.4	2.625	0.105
	Every time	64.6	35.4		
Type of feed supplement (%)	Commercial rations	48.1	51.9	3.701	0.054
	Homemade rations	68.4	31.6		

***Significant at (p<0.05)**

Multiple regression was used to determine the magnitude and direction of feeding management on milk production levels by exotic goats. From the analysis, it was revealed that, holding all other independent variables constant at zero, a unit increase in types of pastures and fodder planted, type grazing system used and feed supplement adopted caused a 0.008, 0.003 and 0.018 increases in milk production levels of exotic goats however, a unit increases in frequency and time of feed supplementation caused a 0.019 and 0.006 decrease in milk production levels of exotic goats respectively.

Frequency of feed supplementation and the type of feed supplement had more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.018 (Table 4.3.1.1b)

Table 4.3.1.1bfeeding in exotic goats

Feeding in exotic goats	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168
Type of pastures/fodder	0.008	0.032	0.007	0.238	0.813
Type of grazing system	0.003	0.023	0.003	0.151	0.881
Frequency of feed supplementation	-0.019	0.038	-0.018	-0.490	0.626
Time of feed supplementation	-0.006	0.033	-0.006	-0.189	0.851
Type of feed supplement	0.018	0.021	0.018	0.849	0.400

Figure 4.3.1 Feed supplementation during the dry season using Acacia pods

4.3.1.2 Feeding in indigenous goats

Descriptive statistics using cross tab chi square revealed that there was an association between levels of milk production by indigenous goats and the type of pasture planted and the frequency of feed supplementation at ($\chi^2 = 18.283$ p = 0.000, and $\chi^2 = 28.525$ p = 0.00) respectively since over 50 % of respondents reported using fodder legumes and supplementing their goats frequently (Table 4.3.1.2a).

Table 4.3.1.2a feeding in indigenous goats

Feeding in indigenous goats		**Milk production levels in indigenous goats**		χ^2	**p**
		< 1 litres	**>1 litres**		
Type of pasture (%)	pasture grasses	92.9	7.1	18.283	0.000*
	Fodder legumes	45.2	54.8		
Type of grazing system (%)	Intensive	64.3	35.7	0.603	0.438
	Extensive	56.2	43.8		
Frequency of feed supplementation (%)	Frequent	41	59	28.525	0.000*
	Not frequent	60	40		
Time of feed supplementation (%)	Pregnant/milking	50	50	3.281	0.070
	Every time	68.8	31.2		
Type of feed supplement (%)	Commercial rations	53.8	46.2	1.943	0.161
	Homemade rations	68.4	31.6		

***Significant at ($p<0.05$)**

Multiple regression was again used to determine the magnitude and direction of feeding management factors on milk production levels by indigenous goats. From the analysis, it was revealed that, holding all other independent variables constant at zero, a unit increase

in types of pastures and type of feed supplement adopted caused a 0.012 and 0.010 increase in milk production levels of indigenous goats however, a unit increase in Type of grazing system, frequency and time of feed supplementation caused a 0.024, 0.013 and 0.081 decreases in milk production levels of indigenous goats respectively. Time of feed supplementation had more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.083 (Table 4.3.1.2b).

Table 4.3.1.2b feeding in indigenous goats

Feeding in indigenous goats	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168
Type of pastures/fodder	0.012	0.053	0.012	0.235	0.815
Type of grazing system	-0.024	0.037	-0.024	-0.638	0.526
Frequency of feed supplementation	-0.013	0.062	-0.012	-0.206	0.837
Time of feed supplementation	-0.081	0.053	-0.083	-1.530	0.132
Type of feed supplement	0.010	0.034	0.010	0.299	0.766

4.3.2.1 Watering in exotic goats

Descriptive statistics using cross tab chi square revealed that there was an association between frequency of watering, distances to watering points and sources of water at (χ^2 = 28.944 p = 0.000, χ^2 = 57.02 p = 0.00 and χ2 = 18.915 p = 0.000*) respectively with those respondents who reported high milk production levels in exotic goats saying that they watered their goats daily with piped water or borehole water within a distance of less than 0.5 km (Table 4.3.2.1a).

Table 4.3.2.1a watering in exotic goats

Watering in exotic goats		**Milk production levels in exotic goats**		**χ^2**	**p**
		<2 litres	**>2 litres**		
Frequency of goat watering (%)	Daily	29.8	70.2	28.944	0.000*
	Alternate	86	14		
Sources of waters (%)	Piped water/borehole	35.4	64.6	18.915	0.000*
	Shallow wells/river bed	81	19		
Distances to the watering point (%)	>0.5km	10.5	89.5	57.021	0.000*
	<0.5km	90.4	9.6		

***Significant at (p<0.05)**

Regression analysis revealed that, holding all other independent variables constant at zero, a unit increase in frequency of watering increased milk production levels by 0.025 however a unit increase in sources of water and distances to watering points decreased milk production levels by 0.025 and 0.002 respectively with sources of water having the highest effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.026 (Table 4.3.2.1b).

Table 4.3.2.1b watering in exotic goats

Watering in exotic goats	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168
Frequency of goat watering	0.025	0.025	0.025	0.990	0.327
Sources of waters	-0.025	0.023	-0.026	-1.122	0.267
Distances to the watering point	-0.002	0.036	-0.002	-0.065	0.948

4.3.2.2 Watering in indigenous goats

Descriptive statistics using cross tab chi square revealed that there was an association between frequency of watering, distances to watering points and sources of water at (χ^2 = 32.331 p = 0.000, χ^2 = 17.865 p = 0.00 and $\chi 2$ = 53.563 p = 0.000*) respectively with those respondents who reported high milk production levels in indigenous goats saying

that they watered their goats daily with piped water or borehole water in a distance of less than 0.5 km (Table 4.3.2.2a).

Table 4.3.2.2a watering in indigenous goats

Watering in indigenous goats		**Milk production levels in indigenous goats**		χ^2	**p**
		< 1 litres	**>1 litres**		
Frequency of goat watering (%)	Daily	31.9	68.1	32.331	0.000*
	Alternate	90.7	9.3		
Sources of waters (%)	Piped water/borehole	39.6	60.4	17.865	0.000*
	Shallow wells/river bed	83.3	16.7		
Distances to the watering point (%)	>0.5km	15.8	84.2	53.563	0.000*
	<0.5km	92.3	7.7		

***Significant at (p<0.05)**

Regression analysis revealed that, taking all other independent variables constant at zero, a unit increase in frequency of watering, sources of water and distances to watering points decreased milk production levels by 0.052, 0.044 and 0.082 respectively with distances to watering points having the more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.083 (Table 4.3.2.2b).

Table 4.3.2.2b watering in indigenous goats

Watering in indigenous goats	Un standardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.284	0.553		0.514	0.609
Frequency of goat watering	-0.052	0.041	-0.053	-1.273	0.208
Sources of waters	-0.044	0.037	-0.045	-1.191	0.239
Distances to the watering point	-0.082	0.058	-0.083	-1.412	0.164

4.3.3.1 Housing in exotic goats

Descriptive statistics using cross tab chi square revealed that there was an association between goat housing, type of goat house and frequency of goat house cleaning at (χ^2 = 42.240 p = 0.000, χ^2 = 3.893 p = 0.048 and χ2 = 26.095 p = 0.000*) respectively with those respondents who reported high milk production levels in exotic goats confirming that they housed and cleaned their goat houses frequently (Table 4.3.3.1a).

Table 4.3.3.1a Housing in exotic goats

Housing in exotic goats		**Milk production levels in exotic goats**		χ^2	**p**
		<2 litres	**>2 litres**		
Goat housing (%)	Frequent	28.3	71.7	42.240	0.000*
	Not frequent	97.3	2.7		
Type of goat house (%)	Local goat house	46.8	53.2	3.893	0.048*
	Improved goat house	67.4	32.6		
Frequency of goat house cleaning (%)	Twice per week	33.3	66.7	26.095	0.000*
	Once per week	87.2	12.8		

***Significant at (p<0.05)**

Regression analysis revealed that, holding all other independent variables constant at zero, a unit increase in frequency of goat house cleaning increased milk production levels by 0.011 however a unit increase in type of house and number of farmers practicing goat housing decreased milk production levels by 0.012 and 0.032 respectively with housing of goats having the highest effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.032 (Table 4.3.3.1b).

Table 4.3.3.1b Housing in exotic goats

Housing in exotic goats	**Un standardized Coefficients**	**Standardized Coefficients**	**t**	**Sig.**

	B	Std. Error	Beta		
(Constant)	0.472	0.338		1.396	0.168
Goat housing	-0.032	0.027	-0.032	-1.176	0.244
Type of goat house	-0.012	0.020	-0.012	-0.609	0.545
Frequency of goat house cleaning	0.011	0.025	0.011	0.427	0.671

Figure 4.3.2 Raised level goat housing using locally available materials

Figure 4.3.3 Ground level goat housing

4.3.3.2 Housing in indigenous goats

Descriptive statistics using cross tab chi square revealed that there was an association between goat housing and frequency of goat house cleaning at (χ^2 = 36.418 p = 0.000, and χ2 = 29.932 p = 0.000*) respectively with those respondents who reported high milk production levels in indigenous goats confirming that they housed and cleaned their goat hoses frequently (Table 4.3.3.2a).

Table 4.3.3.2a Housing in indigenous goats

Housing in indigenous goats		**Milk production levels in indigenous goats**		**χ^2**	**p**
		<1 litres	**>1 litres**		
Goat housing (%)	Frequent	34	66	36.418	0.000*

	Not frequent	97.3	2.7		
Type of goat house (%)	Local goat house	51.1	48.9	3.273	0.070
	Improved goat house	69.8	30.2		
Frequency of goat house cleaning (%)	Twice per week	35.3	64.7	29.932	0.000*
	Once per week	92.3	7.7		

***Significant at (p<0.05)**

Regression analysis revealed that, holding all other independent variables constant at zero, a unit increase in type of goat house adopted increased milk production levels by 0.012 however a unit increase in number of farmers practicing goat housing and frequency of cleaning decreased milk production levels by 0.024 and 0.089 respectively with frequency of goat house cleaning having the highest effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.090 (Table 4.3.3.2b).

Table 4.3.3.2b Housing in indigenous goats

Housing in indigenous goats	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.284	0.553		0.514	0.609
Goat housing	-0.024	0.045	-0.024	-0.536	0.594

Type of goat house	0.012	0.032	0.013	0.391	0.698
Frequency of goat house cleaning	-0.089	0.040	-0.090	-2.208	0.031

4.3.4.1 Disease management in exotic goats

Analysis using cross tab chi square revealed that there was an association between milk production levels and frequency of common diseases and pests, frequency of spraying and deworming goat at (χ^2 = 63.711 p = 0.000, χ^2 = 86.006 p = 0.048 and χ2 =82.163p = 0.000) respectively with those respondents who said they sprayed and dewormed their goats regularly reporting high milk production levels (Table 4.3.4.1a).

Table 4.3.4.1a Disease management in exotic goats

Disease management factors		**Milk production levels in exotic goats**		**χ^2**	**p**
		<2 litres	**>2 litres**		
Frequency of common diseases and pests (%)	Frequent	92.3	7.7	63.711	0.000*
	Not frequent	7.9	92.1		
Frequency of goat vaccination (%)	None	57.9	42.1	0.095	0.757
	As per vaccination regime	54.5	45.5		
Frequency of goat spraying/dipping (%)	None	98.1	1.9	86.006	0.000*
	As per	0.0	100.0		

	spraying regime				
Frequency of goat drenching %)	None	96.2	3.8	82.163	0.000*
	As per deworming regime	0.0	100		

***Significant at (p<0.05)**

On the other hand, regression analysis revealed that, holding all other independent variables constant at zero, a unit increase in frequency of common diseases and pests, frequency of spraying and frequency of deworming increased milk production levels by 0.065,0.437 and 0.187 respectively however a unit increase in vaccination decreased milk production levels by 0.005 with frequency of spraying having more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.435 (Table 4.3.4.2). Frequency of common diseases and pests, frequency of spraying and frequency of drenching were significantly different from zero at P<0.05 since they all had (t = 63.711 p = 0.000, t = 86.006 p = 0.000 and t = 82.163 p = 0.000) respectively (Table 4.3.4.1b).

Table 4.3.4.1b Disease management in exotic goats

Diseases management factors	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168

Frequency of common diseases and pests	0.065	0.039	0.064	1.676	0.099
Frequency of goat vaccination	-0.005	0.028	-0.005	-0.184	0.855
Frequency of goat spraying/dipping	0.437	0.066	0.435	6.586	0.000*
Frequency of goat drenching	0.187	0.081	0.186	2.306	0.025*

***Significant at (p<0.05)**

4.3.4.2 Disease management in indigenous goats

Analysis using cross tab chi square revealed that there was an association between milk production levels in indigenous goats with frequency of common diseases and pests, frequency of spraying and deworming goats at (χ^2 = 67.075 p = 0.000, χ^2 = 82.105 p = 0.048 and χ2 =70.495 p = 0.000) respectively with respondents who said they sprayed and dewormed their goats regularly reporting high milk production levels (Table 4.3.4.2a).

Table 4.3.4.2a Disease management in indigenous goats

Disease management factors		**Milk production levels in indigenous goats**		**χ^2**	**p**
		< 1litres	**>1 litres**		
Frequency of common diseases	Frequent	96.2	3.8	67.075	0.000*
	Not frequent	10.5	89.5		

and pests (%)					
Frequency of goat vaccination (%)	None	63.2	36.8	0.646	0.422
	As per vaccination regime	54.5	45.5		
Frequency of goat spraying/dipping (%)	None	100	0	82.105	0.000*
	As per spraying regime	5.3	94.7		
Frequency of goat drenching %)	None	96.2	3.8	70.495	0.000*
	As per deworming regime	8.1	91.9		

***Significant at (p<0.05)**

On the other hand, regression analysis revealed that, holding all other independent variables constant at zero, a unit increase in frequency of common diseases and pests, frequency of vaccination and frequency of spraying increased milk production levels by 0.215, 0.082 and 0.767 respectively however a unit increase in drenching decreased milk production levels by 0.094 with frequency of spraying having more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.773. Frequency of common diseases and pests and frequency of spraying were significantly different from zero at P<0.05 since they had (t = 3.410 p = 0.001, t = and t = 7.080 p = 0.000) respectively (Table 4.3.4.2b).

Table 4.3.4.2b Disease management in indigenous goats

Disease management factors	Un standardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.284	0.553		0.514	0.609
Frequency of common diseases and pests	0.215	0.063	0.216	3.410	0.001*
Frequency of goat vaccination	0.082	0.046	0.081	1.800	0.077
Frequency of goat spraying/dipping	0.767	0.108	0.773	7.080	0.000*
Frequency of goat drenching	-0.094	0.133	-0.094	-0.706	0.483

***Significant at (p<0.05)**

4.3.5.1 Breeding management in exotic goats

Analysis using cross tab chi square revealed that there was an association between breeding management (frequency of inbreeding, castration, culling, buck exchange , buck rotation and selection) with milk production levels of exotic goats at (χ^2 = 9.311 p = 0.002, χ^2 = 33.880 p = 0.000, $\chi2$ = 15.388 p = 0.000, $\chi2$ = 78.203 p = 0.000, $\chi2$ = 36.883 p = 0.000 and $\chi2$ = 13.904 p = 0.000) respectively with respondents who said they frequently used these tools reporting high milk production levels (Table 4.3.5.1a).

Table 4.3.5.1a breeding management in exotic goats

Breeding management factors		**Milk production levels in exotic goats**		**χ^2**	**p**
		<2 litres	**>2 litres**		
Frequency of inbreeding (%)	Frequent	44.8	55.2	9.311	0.002*
	Not frequent	78.1	21.9		
Castration as control of inbreeding (%)	Frequent	17.6	82.4	33.880	0.000*
	Not frequent	80.4	19.6		
Culling as control of inbreeding (%)	Frequent	45.7	54.3	15.388	0.000*
	Not frequent	95	5		
Buck exchange as control of inbreeding (%)	Frequent	2.6	97.4	78.203	0.000*
	Not frequent	96.2	3.8		
Buck rotation as control of inbreeding (%)	Frequent	12.9	87.1	36.883	0.000*
	Not frequent	79.7	20.3		
Selection as up grading tool (%)	Frequent	45.6	54.4	13.904	0.000*
	Not frequent	90.9	9.1		

***Significant at (p<0.05)**

Multiple regression analysis revealed that, taking all other variables constant at zero, a unit increase in use of castration and culling as a breeding management tool increased milk production levels by 0.069 and 0.007 respectively however a unit increase buck exchange, buck rotation and selection as a breeding management tool decreased milk production levels by 0.085, 0.082 and 0.001 respectively with use of buck exchange having more effects to milk production levels because it had the largest absolute **β** (standardized beta coefficient) of 0.085 (Table 4.3.5.1b).

Table 4.3.5.1b breeding management in exotic goats

Breeding management factors	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168
Frequency of inbreeding	0.000	0.022	0.000	-0.013	0.990
Castration as control of inbreeding	0.069	0.060	0.068	1.157	0.252
Culling as control of inbreeding	0.007	0.033	0.006	0.221	0.826
Buck exchange as control of inbreeding	-0.085	0.064	-0.085	-1.328	0.190
Buck rotation as control of inbreeding	-0.082	0.057	-0.078	-1.435	0.157

Selection as up grading tool	-0.001	0.029	-0.001	-0.022	0.982

4.3.5.2 Breeding management in indigenous goats

Analysis using cross tab chi square revealed that there was an association between milk production levels of indigenous goats and breeding management factors (frequency of inbreeding, castration, culling, buck exchange , buck rotation and selection) at (χ^2 = 9.343 p = 0.002, χ^2 = 30.284 p = 0.000, χ2 = 17.143 p = 0.000, χ2 = 67.075 p = 0.000, χ2 = 32.551 p = 0.000 and χ2 = 11.591 p = 0.000) respectively with those respondents who said they frequently used these tools reporting high milk production levels (Table 4.3.5.2a).

Table 4.3.5.2a breeding management in indigenous goats

Breeding management factors		**Milk production levels in indigenous goats**		**χ^2**	**p**
		<1 litres	**>1 litres**		
Frequency of inbreeding (%)	Frequent	48.3	51.7	9.343	0.002*
	Not frequent	81.2	18.8		
Castration as control of inbreeding (%)	Frequent	23.5	76.5	30.284	0.000*
	Not frequent	82.1	17.9		
Culling as control of inbreeding (%)	Frequent	48.6	51.4	17.143	0.000*
	Not frequent	100	0		

Buck exchange as control of inbreeding (%)	Frequent	10.5	89.5	67.075	0.000*
	Not frequent	96.2	3.8		
Buck rotation as control of inbreeding (%)	Frequent	19.4	80.6	32.551	0.000*
	Not frequent	81.4	18.6		
Selection as up grading tool (%)	Frequent	50	50	11.591	0.001*
	Not frequent	90.9	9.1		

***Significant at (p<0.05)**

Regression analysis revealed that, taking all other variables constant at zero, a unit increase in use of buck exchange, buck rotation and selection as a breeding management tool increased milk production levels by 0.208, 0.089 and 0.004 respectively however a unit increase frequency of inbreeding, castration and culling as a breeding management tool decreased milk production levels by 0.025, 0.071 and 0.087 respectively with use of buck exchange having more effects to milk production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.210 (Table 4.3.5.2b).

Table 4.3.5.2b breeding management in indigenous goats

Breeding management factors	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.284	0.553		0.514	0.609
Frequency of inbreeding	-0.025	0.036	-0.024	-0.688	0.494

Castration as control of inbreeding	-0.071	0.097	-0.070	-0.724	0.472
Culling as control of inbreeding	-0.087	0.053	-0.074	-1.629	0.109
Buck exchange as control of inbreeding	0.208	0.105	0.210	1.990	0.052
Buck rotation as control of inbreeding	0.089	0.093	0.087	0.963	0.340
Selection as up grading tool	0.004	.047	0.003	0.079	0.937

4.4 Social and economic factors influencing dairy goat milk production.

4.4.1 Social factors

4.4.1.1 Social factors affecting exotic goat milk production levels

The social factors considered in the study included; level of education, experience of dairy goat keeping and affiliation to self-help group (Table 4.4.1.1). Analysis using cross tabs chi square revealed that there was an association between education levels, experience and group membership with the levels of milk production levels of exotic goats at ($\chi2 = 42.824$, $p = 0.000$, $\chi2 = 23.538$ $p = 0.000$ and $\chi2 = 44.754$ $p = 0.000$) since higher milk production levels were reported among farmers who were members of self-help groups with more experience in goat keeping and having secondary or tertiary education (Table 4.4.1.1a).

Table 4.4.1.1a Social factors affecting exotic goat milk production levels

Social factor		**Milk production levels in exotic goats**		χ^2	**p**
		< 2 litres	**>2 litres**		
Level of education (%)	Primary	89.4	10.6	42.824	0.000*
	Above primary	20.9	79.1		
Experience (%)	< 5 years	85	15	23.538	0.000*
	>5 years	34	66		
Group membership (%)	Member	15.8	84.2	44.754	0.000*
	Non-member	86.5	13.5		

***Significant at (p<0.05)**

Multiple regression analysis revealed that, taking all other variables constant at zero, a unit increase in experience of goat keeping increased milk production levels by 0.022 however a unit increase level of education and membership to self-help group decreased milk production levels by 0.011 and 0.021 respectively with experience in goat keeping having more effects to milk production levels because it had the largest absolute **β** (standardized beta coefficient) of 0.022 (Table 4.4.1.1b).

Table 4.4.1.1b Social factors affecting exotic goat milk production levels

Social factors	Un standardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.472	0.338		1.396	0.168
Level of education	-0.011	0.032	-0.011	-0.346	0.730
Experience in goat keeping	0.022	0.023	0.022	0.935	0.354
Membership to self-help group	-0.021	0.032	-0.021	-0.660	0.512

4.4.1.2 Social factors affecting indigenous goat milk production levels

Analysis using cross tabs chi square revealed that there was an association between education levels, experience and group membership with the levels of milk production levels of indigenous goats at ($\chi 2 = 35.336$, $p = 0.000$, $\chi 2 = 18.750$ $p = 0.000$ and $\chi 2 = 36.141$ $p = 0.000$) since higher milk production levels were reported among farmers who were members of self-help groups with more experience in goat keeping and having secondary or tertiary education (Table 4.4.1.2a).

Table 4.4.1.2a Social factors affecting indigenous goat milk production levels

Social factors		**Milk production levels in indigenous goats**		χ^2	**p**
		< 1 litres	**>1 litres**		
Level of education (%)	Primary	89.4	10.6	35.336	0.000*
	Above primary	27.9	72.1		
Experience (%)	< 5 years	85	15	18.750	0.000*
	>5 years	40	60		
Group membership (%)	Member	23.7	75.3	36.141	0.000*
	Non-member	86.5	13.5		

***Significant at (p<0.05)**

Multiple regression analysis revealed that, taking all other variables constant at zero, a unit increase in experience of goat keeping and membership to self-help group increased milk production levels by 0.019 and 0.005 respectively however a unit increase level of education decreased milk production levels by 0.024 with level of education having more effects to milk production levels because it has the largest absolute **β** (standardized beta coefficient) of 0.024 (Table 4.4.1.2b).

Table 4.4.1.2b Social factors affecting indigenous goat milk production levels

Social factors	Un standardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.284	0.553		0.514	0.609
Level of education	-0.024	0.053	-0.024	-0.453	0.653
Experience in goat keeping	0.019	0.038	0.019	0.502	0.618
Membership to self-help group	0.005	0.053	0.005	0.096	0.924

4.4.2. Economic factors

4.4.2.1 Economic factors affecting exotic goat milk production levels

The economic factors affecting exotic goat milk production analyzed were per capita household income, household income sources, presence of credit facilities and access to credit facilities. Cross tab chi square used in the analysis revealed that all these economic variables analyzed were associated with milk production levels of exotic goats at (χ^2 = 20.445 p = 0.000, χ^2 = 6.210 p = 0.013, χ^2 = 5.269 p = 0.022 and χ^2 = 38.077 p = 0.000). Those farmers who reported higher milk production levels said they had a higher per capita income from other sources apart from farming and they frequently accessed credit for their farming activities (Table 4.4.2.1a).

Table 4.4.2.1a Economic factors affecting exotic goat milk production levels

Economic factors		**Milk production levels in exotic goats**		χ^2	**P**
		< 2litres	**>2 litres**		
Per capita household income (%)	<15,000 Ksh	95.8	4.2	20.445	0.000*
	>15,000 Ksh	42.4	57.6		
Household income sources (%)	Farming	66.1	33.9	6.210	0.013*
	Other sources	38.7	61.3		
Presence of credit facilities (%)	yes	49.2	50.8	5.269	0.022*
	no	76	24		
Accessibility to credit facilities (%)	yes	0.0	100	38.077	0.000*
	no	75	25		

***Significant at (p<0.05)**

Multiple regression analysis revealed that, taking all other variables constant at zero, a unit increase in per capita household incomes and household income sources increased milk production levels by 0.005 and 0.013 respectively while a unit increase in presence of credit facilities and accessibility to them decreased milk production levels by 0.006 and 0.026 respectively with accessibility of credit having more effects to milk

production levels since it had the largest absolute **β** (standardized beta coefficient) of 0.022 (Table 4.4.2.1b).

Table 4.4.2.1b Economic factors affecting exotic goat milk production levels

Social factors	**Un standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	0.472	0.338		1.396	0.168
Per capita household income	0.005	0.025	0.004	0.194	0.847
Household income sources	0.013	.023	0.013	0.572	0.570
Presence of credit facilities	-0.006	0.026	-0.005	-0.232	0.818
Accessibility of credit	-0.026	0.035	-0.022	-0.740	0.462

4.4.2.2 Economic factors affecting indigenous goat milk production levels

Cross tab chi square used in the analysis revealed that all these economic variables analyzed except presence of credit facilities were associated with milk production levels of indigenous goats at ($\chi^2 = 17.509$ p = 0.000, $\chi^2 = 8.931$ p = 0.003, $\chi^2 =$ and $\chi^2 = 38.077$ p = 0.000). Those farmers who reported higher milk production levels said they had a higher per capita income from other sources apart from farming and they frequently accessed credit for their farming activities (Table 4.4.2.2a).

Table 4.4.2.2a Economic factors affecting indigenous goat milk production levels

Economic factors		**Milk production in indigenous goats**		χ^2	**P**
		< 1litres	**>1 litres**		
Per capita household income (%)	<15,000 Ksh	95.8	4.2	17.509	0.000*
	>15,000 Ksh	47	53		
Household income sources (%)	Farming	71.2	28.8	8.931	0.003*
	Other sources	38.7	61.3		
Presence of credit facilities (%)	yes	53.8	46.2	3.692	0.055
	no	76	24		
Accessibility to credit facilities (%)	yes	4.5	95.5	37.309	0.000*
	no	77.9	22.1		

***Significant at (p<0.05)**

Multiple regression analysis revealed that, taking all other variables constant at zero, a unit increase in per capita household incomes and household income sources increased milk production levels by 0.004 and 0.026 respectively while a unit increase presence of credit facilities and accessibility to them decreased milk production levels by 0.036 and 0.079 respectively with accessibility of credit having more effects to milk production levels due to its larger absolute **β** (standardized beta coefficient) of 0.069 (Table 4.4.2.2b).

Table 4.4.2.2b Economic factors affecting indigenous goat milk production levels

Social factors	Un standardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.284	0.553		0.514	0.609
Per capita household income	0.004	0.041	0.003	0.088	0.930
Household income sources	0.026	0.038	0.025	0.696	0.490
Presence of credit facilities	-0.036	0.042	-0.033	-0.868	0.389
Accessibility of credit	-0.079	0.057	-0.069	-1.383	0.172

4.5 The role of dairy goat keeping on rural livelihoods

4.5.1 Improvement of income levels

4.5.1.1 Importance of keeping exotic goats to improve income

The study looked at role of dairy goat keeping towards improvement of income through various income generating activities practiced by the farmers. The study analyzed the reasons of keeping exotic goats to test for any statistical significance in improving income levels of the farmers within the study area. Analysis using cross tabs chi square revealed that, all the variables tested had significant effects ($p<0.05$) to milk production levels by exotic goats. Importance of keeping exotic goats to sell milk and meat to improve income was significant ($\chi^2 = 50.463$ $p = 0.000$, $\chi^2 = 33.457$ $p = 0.000$

respectively) effects to milk production levels with 90.4% and 88.9 % of them respectively, who earned higher per capita income saying that it was important (Table 4.5.1.1). Importance of keeping exotic goats for sale of manure and off springs to improve income had also significant to milk production levels with 68.6% and 79.1% of them respectively, who had higher per capita income saying that it was important (Table 4.5.1.1a).

Table 4.5.1.1a Importance of keeping exotic goats to improve income

Variable		**Per capita household income (Ksh)**		**χ^2**	**p**
		< 15,000	**>15,000**		
Importance of keeping goats for milk to earn income (%)	Not important	84.2	15.8	50.463	0.000*
	Important	9.6	90.4		
Importance of keeping goats for meat to earn income (%)	Not important	71.1	28.9	33.457	0.000*
	Important	11.1	88.9		
Importance of keeping goats for sale of manure to earn income (%)	Not important	68.6	31.4	36.808	0.000*
	Important	5.1	94.9		
Importance of keeping goats for sale of offspring	Not important	79.1	20.9	49.005	0.000*

to earn income (%)	Important	6.4	93.6		

***Significant at (p<0.05**

The mean levels of income for those who earned more or less than Ksh 15,000 per capita income were tested for significant difference using analysis of variance (ANOVA). The results revealed that, there was significant differences (p<0.05) in the means of importance of keeping goats for milk, meat, manure and off springs as a source of income at (F=112.319, p <0.000; F=52.071, p <0.000; F=60.893, p <0.000 and F=105.195, p <0.000) respectively (Table 4.5.1.1b).

Table 4.5.1.1b Importance of keeping exotic goats to improve income

Variable	**Income levels**	**df**	**F**	**Sig.**
Importance of keeping goats for milk to earn income	Between groups of those who earned less or more than Ksh 1000	1	112.319	0.000*
	Within Groups	88		
	Total	89		
Importance of keeping goats for meat to earn income	Between groups of those who earned less or more than Ksh 1000	1	52.071	0.000*
	Within Groups	88		
	Total	89		
Importance of keeping goats for manure to earn income	Between groups of those who earned less or more than Ksh 1000	1	60.893	0.000*
	Within Groups	88		
	Total	89		

Importance of keeping goats for sale of offspring to earn income	Between groups of those who earned less or more than Ksh 1000	1	105.195	0.000*
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

4.5.1.2 Importance of keeping indigenous goats to improve income

There were significant (p<0.05) effects of keeping indigenous goats for sale of milk, meat, manure and offspring to improve income levels with 88.5% of respondents who said it was important goats for milk and meat to earn income reporting more than Ksh. 15,000 per capita income from indigenous goats (Table 4.5.1.2a). Sale of manure and live goats significantly improved income at (χ^2 = 33.638 p = 0.000, and χ^2 = 51.795 p = 0.000) with 92.3% who sold manure and 93.6% who sold live animals earning more than Ksh 15,000 per capita income from indigenous goats (Table 4.5.1.2a).

Table 4.5.1.2a Importance of keeping local goats to improve income

Variable		**Per capita household income (Ksh)**		**χ2**	**P**
		< 15,000	**>15,000**		
Importance of keeping goats for milk to earn income (%)	Not important	84.2	15.8	47.531	0.000*
	Important	11.5	88.5		
Importance of keeping goats for meat to earn	Not important	73.3	26.7	35.709	0.000*

income (%)	Important	11.1	88.5		
Importance of keeping goats for sale of manure to earn income (%)	Not important	68.6	31.4	33.638	0.000*
	Important	7.7	92.3		
Importance of keeping goats for sale of offspring to earn income (%)	Not important	81.4	18.6	51.795	0.000*
	Important	6.4	93.6		

***Significant at (p<0.05)**

The mean levels of income for those who earned more or less than Ksh 15,000 per capita income per capita income was tested for significant difference using analysis of variance (ANOVA). The results showed that, there was significant differences ($p<0.05$) in the means of importance of keeping goats for milk, meat, manure and off springs as a source of income at ($F=98.489$, $p <0.000$; $F=57.879$, $p <0.000$; $F=52.519$, $p <0.000$ and $F=119.303$, $p <0.000$) respectively (Table 4.5.1.2b).

Table 4.5.1.2b Importance of keeping indigenous goats to improve income

Variable	**Income levels**	**df**	**F**	**Sig.**
Importance of keeping goats for milk to earn income	Between groups of those who earned less or more than Ksh 500	1	98.489	0.000*
	Within Groups	88		
	Total	89		
Importance of keeping goats for meat to earn income	Between groups of those who earned less or more than Ksh 1000	1	57.879	0.000*

	Within Groups	88		
	Total	89		
Importance of keeping goats for manure to earn income	Between groups of those who earned less or more than Ksh 1000	1	52.519	0.000*
	Within Groups	88		
	Total	89		
Importance of keeping goats for sale of offspring to earn income	Between groups of those who earned less or more than Ksh 1000	1	119.303	0.000*
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

4.5.1.3 Utilization of the income from goat keeping

Analysis using chi square was done to test the level of significance as far as utilizing the income from goats was concerned. Results showed that the frequency of using per capita income from goats to purchase food and pay school fees was significant effects ($p<0.05$) to improvement of rural livelihoods at ($\chi^2 = 6.222$ $p = 0.013$and $\chi^2 = 4.160$ $p = 0.041$ respectively) with 54.5% and 45.6% of farmers in sub humid and semi-arid areas saying they frequently used income to purchase food and 54% and 46% of them in sub humid and semi-arid areas respectively saying they frequently used income to pay for school fees (Table 4.5.1.3a).

Table 4.5.1.3a Utilization of income raised to improve livelihoods

Variable		Type of ecological zone		χ^2	p
		sub humid	semi-arid		
Frequency of using income to purchase food (%)	Frequent	54.4	45.6	6.222	0.013*
	Not frequent	27.3	72.7		
Frequency of using income to purchase cloths (%)	Frequent	45.5	54.5	0.036	0.850
	Not frequent	43.5	56.5		
Frequency of using income to pay school fees (%)	Frequent	54	46	4.160	0.041*
	Not frequent	32.5	67.5		
Frequency of using income to buy drugs/ medical bills (%)	Frequent	47.4	52.6	0.538	0.463
	Not frequent	39.4	60.6		

***Significant at (p<0.05)**

The means of respondents in sub humid and semi-arid zone was tested for significant difference using analysis of variance (ANOVA). The results showed that, there was significant differences ($p<0.05$) in the means of frequency of using income to purchase food and pay school fees at ($F=6.536$, $p<0.012$ and $F=4.265$, $p<0.042$) respectively (Table 4.5.1.3b).

Table 4.5.1.3b Utilization of income raised to improve livelihoods

Variable	Ecological zone	df	F	Sig.
Frequency of using income to purchase food	Between Groups of those in sub humid and those in semi-arid zones	1	6.536	0.012*
	Within Groups	88		
	Total	89		
Frequency of using income to purchase clothes	Between Groups of those in sub humid and those in semi-arid zones	1	0.035	0.852
	Within Groups	88		
	Total	89		
Frequency of using income to pay school fees	Between Groups of those in sub humid and those in semi-arid zones	1	4.265	0.042*
	Within Groups	88		
	Total	89		
Frequency of using income to purchase drugs/medical bills	Between Groups of those in sub humid and those in semi-arid zones	1	0.529	0.469
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

4.5.2 Improvement nutrition levels

4.5.2.1 Goat milk production and utilization

Milk production levels and its utilization were analyzed to assess its effects towards nutritional improvement. The variables tested were milk consumption at household level by all family members, children and the old and milk sales to the neighbor and trader. The study revealed that milk production by exotic goats for consumption by children the old and all other family members as well as sale to traders had significant effects ($p<0.05$) to improvement of nutritional levels at ($\chi^2 = 45.184$ $p = 0.000$, $\chi^2 = 37.649$ $p = 0.000$ and $\chi^2 = 31.677$, $p = 0.000$) respectively with 81.7% and 92.6% of respondents who produced less than 2 litres per day indicating that they used less than 0.5 litres of milk for consumption by old and children and other family members respectively, while 70.2 % of respondents who produced more than 2 litres per day sold more than 0.5 litres of milk to traders(Table 4.5.2.1a).

Table 4.5.2.1aExotic goat milk production and utilization

Variable		**Milk production levels in exotic goats**		**χ^2**	**p**
		< 2 litres	**>2 litres**		
Daily consumption by children and old (%)	<0.5 litres	81.7	18.3	45.184	0.000*
	>0.5 litres	6.7	93.3		
Daily consumption by all family members (%)	<0.5 litres	92.5	7.5	37.649	0.000*
	>0.5 litres	28	72		
Daily milk sale to	<0.5 litres	55.6	44.4	0.407	0.523

neighbours (%)	>0.5 litres	66.7	33.3		
Daily milk sale to traders (%)	<0.5 litres	88.1	11.9	31.677	0.000*
	>0.5 litres	29.2	70.8		

***Significant at (p<0.05)**

The means of respondents who produced more or less than 2 litres of milk was tested for significant differences. The results showed that, there was significant differences ($p<0.05$) in the means of daily consumption by children and old, all family members and sale to traders at ($F=91.244$, $p<0.000$; $F=63.287$, $p<0.000$ and $F=47.797$, $p<0.000$) respectively (Table 4.5.2.1b).

Table 4.5.2.1b Exotic goat milk production and utilization

Variable	**Milk production levels**	**df**	**F**	**Sig.**
Daily consumption by children and old	Between Groups of those producing more or less than 2 litres	1	91.244	0.000*
	Within Groups	88		
	Total	89		
Daily consumption by all family members	Between Groups of those producing more or less than 2 litres	1	63.287	0.000*
	Within Groups	88		
	Total	89		
Daily milk sale to neighbours	Between Groups of those producing more or less than 2 litres	1	0.400	0.529

	Within Groups	88		
	Total	89		
Daily milk sale to traders	Between Groups of those producing more or less than 2 litres	1	47.797	0.000*
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

Similar effects to nutritional improvement were reported among indigenous goat keepers. Milk production for consumption by young, old, other family members, and sale to traders had significant effects to improve to nutritional requirement of respondents at (χ^2 = 46.875 p = 0.000, χ^2 = 31.688 p = 0.000 and χ^2 = 30.476 p = 0.000 respectively) with 85% who fed milk to their children and old and 92.5% who fed their milk to other family members with less than 0.5 litres of milk reporting production levels of less than 1 litre per day from indigenous goats. About 66.7% of respondents who produced more than 1 litre of milk per day sold more than 0.5 litres of milk (Table 4.5.2.2a).

Table 4.5.2.1c Indigenous goat milk production and utilization

Variable		**Milk production in indigenous goats**		**χ^2**	**p**
		<1 litre	**>1 litre**		
Daily consumption by children and old (%)	<0.5 litres	85	15	46.875	0.000 *
	>0.5 litres	10	90		
Daily consumption by	<0.5 litres	92.5	7.5	31.688	0.000

all family members (%)	>0.5 litres	34	66		*
Daily milk sale to neighbours (%)	<0.5 litres	59.3	40.7	0.185	0.667
	>0.5 litres	66.7	33.3		
Daily milk sale to traders (%)	<0.5 litres	90.5	9.5	30.476	0.000 *
	>0.5 litres	33.3	66.7		

***Significant at (p<0.05)**

The means of respondents who produced more or less than 1 litres of milk was tested for significant differences. The results showed that, there was significant differences ($p<0.05$) in the means of daily consumption by children and old, all family members and sale to traders at ($F=95.652$, $p<0.000$; $F=47.820$, $p<0.000$ and $F=45.056$, $p<0.000$) respectively (Table 4.5.2.2b).

Table 4.5.2.1d Indigenous goat milk production and utilization

Variable	**Milk production levels**	**df**	**F**	**Sig.**
Daily consumption by children and old	Between Groups of those producing more or less than 2 litres	1	95.652	0.000*
	Within Groups	88		
	Total	89		
Daily consumption by all family members	Between Groups of those producing more or less than 2 litres	1	47.820	0.000*
	Within Groups	88		
	Total	89		

Daily milk sale to neighbours	Between Groups of those producing more or less than 2 litres	1	0.181	0.671
	Within Groups	88		
	Total	89		
Daily milk sale to traders	Between Groups of those producing more or less than 2 litres	1	45.056	0.000*
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

4.5.2.2 Milk preference and nutritional value

The milk preference and nutritional value between goats and cattle was tested for the level of significance. The results showed that the preference and nutritional value of goat milk was higher compared to cows' milk due to high solids, low odour, and good flavour. 98.1 % of farmers said they preferred it due to high solids, 90.2% saying it was due to good flavour however 88.2 % disagreed that it was due to low odour (Table 4.5.2.3a).

Table 4.5.2.2a Milk preference and nutritional value

Variable		**Milk preference and nutritional value**		**χ^2**	**p**
		Goats	**Cow**		
High solids (%)	agree	98.1	1.9	86.006	0.000*
	disagree	0	100		
Low odour (%)	agree	15.4	84.6	47.765	0.000*

	disagree	88.2	11.8		
Good flavour (%)	agree	90.2	9.8	53.883	0.000*
	disagree	12.8	87.2		

***Significant at (p<0.05)**

The means of respondent's preference of goat's and cow's milk was tested for significant differences. The results showed that, there was significant differences (p<0.05) in the means of preference due to high solids low odour and good flavour at (F=1894.933, p <0.000; F=99.522, p <0.000 and F=131.286, p <0.000) respectively (Table 4.5.2.3b).

Table 4.5.2.2b Milk preference and nutritional value

Variable	**Milk preference and nutritional value**	**df**	**F**	**Sig.**
High solids	Between groups of milk preference and nutritional value for goat's milk and cow's milk	1	1894.933	0.000*
	Within Groups	88		
	Total	89		
Low odour	Between groups of milk preference and nutritional value for goat's milk and cow's milk	1	99.522	0.000*
	Within Groups	88		
	Total	89		

Good flavour	Between groups of milk preference and nutritional value for goat's milk and cow's milk	1	131.286	0.000*
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

4.5.3 Soil fertility improvement

The importance of keeping both exotic and indigenous goats across the two ecological zones as a source of manure for soil fertility improvement was analyzed The results showed that keeping goats as a source of farm yard manure and the utilization of the manure had significant effects ($p<0.05$) to improvement of soil fertility at ($\chi^2 = 53.803$ $p = 0.000$ and $\chi^2 = 71.082$ $p = 0.000$ respectively) with 90% of who used feacal waste reporting high soil fertility on their farms and 90.2% of respondents who said it was not important reporting low soil fertility of their farms (Table 4.5.3a).

Table 4.5.3a Importance of keeping goats to improve soil fertility

Variable		**Level of farm soil fertility**		χ^2	**p**
		low	**high**		
Importance of keeping goats for farm yard manure (%)	Not important	90.2	7.8	53.803	0.000*
	Important	15.4	84.6		
Utilization of faecal waste (%)	In my farm	10	90	71.082	0.000*

	Not in my farm	98	2		

***Significant at (p<0.05)**

The means of farm soil fertility levels was tested for significant differences. The results showed that, there was significant differences (p<0.05) in the means of high or low soil fertility levels at (F=330.651, p <0.000 and F=130.804, p <0.000) respectively (Table 4.5.3b).

Table 4.5.3b Importance of keeping goats to improve soil fertility

Variable	**Level of farm soil fertility**	**df**	**F**	**Sig.**
Utilization of livestock faecal waste	Between Groups of farms with low or high soil fertility levels	1	330.651	0.000*
	Within Groups	88		
	Total	89		
How important do you keep goats for manure	Between Groups of farms with low or high soil fertility levels	1	130.804	0.000*
	Within Groups	88		
	Total	89		

*** The F statistic is significant at the p<0 .05 level**

CHAPTER FIVE

DISCUSSION

5.1 Characteristics of the respondents.

The study revealed that most of the household's size was less than five. Most households were headed by males who are the owners of production resources and in agreement to (Wani *et al.,* 1993) who noted that the average family size of 3-5 persons and male dominance in goat keeping had the highest frequency in India. Similarly (Bitende *et al.,* 2001) reported that there was a strong bias against women among communities keeping livestock in Africa.

Most of the farmers were aged more than 50 years. Findings by (Doss and Morris, 2001) found that age determines experience of an adopter of a technology and older farmers use their wealth of experience in making decisions in adopting an innovation.

Results from the study, showed that most of the farmers practiced mixed farming earning their income mainly from livestock, crop sales, and petty trade. This agrees with findings of (Oyesola, 2008) that farmers engaged in crop and livestock activities are able generate income and household consumption and similar to (Mamudu *et al.,* 2012) that younger farmers and households with low income are disadvantaged and cannot be able improve production since they cannot adopt modern capital intensive agricultural technologies.

5.2 Environmental factors affecting milk production levels of different goat breeds

The two rain seasons were found to affect milk production in both categories of goats across the two agro ecological zone (AEZ) possibly because they had direct relationship to pasture and fodder growth and production. This was consistent with (Kabirizi *et al*., 2013) who reported that climatic limitations affect feed availability, quality of the feeds, animal performance and farm production. The March May rains were found to have more effects to milk production levels than the October December rains possibly because they are followed by a long dry spell. Semi-arid part of the study area was found to have

less rainfall than the sub humid areas and hence prone to feed shortages during the dry season. This was consistent with (Orindi *et al.,* 2006) and (Recha *et al*., 2013) who reported that agricultural production is constrained by the inadequate rains and frequent droughts leading to crop failure and scarcity of pastures.

Farmers in sub humid areas who mainly kept exotic goats reported low level of soil fertility which affected milk production levels possibly due to small land parcels and over utilization. This is consistent with (Juma and Pica-Ciamarra, 2013) who said that manure from dairy goats provide many environmental benefits, by helping farmers increase the soil fertility of their small farms. Similarly, (Nawathe *et al.,* 1985) reported that a considerable amount of manure is produced by the goats which are of special importance in areas where cattle are of lesser importance. However, temperatures were higher in semi-arid areas than sub humid part. This did not have much effect on milk production by both categories since it was not to the extreme. However, it was in contrast to (Busono *et al.,* 2012) who reported that hot temperatures had greatest stress effect on pregnant goats followed by young non-pregnant and lactating goats. Extreme temperature cause fast drying of pasture, fodder and water sources through evaporation and transpiration especially in semi-arid areas and similar to (Sombroek *et al.,* 1982) who noted that semi-arid areas were characterized by seasonal availability of natural forage and inadequate surface water due to erratic and unreliable rainfall.

There was a relationship between the type of goat kept and the agro ecological zone with a large percentage of exotic goats being kept in sub humid areas while indigenous goats are more preferred in semi-arid areas. This could possibly be due to the adaptability of specific breeds with indigenous goats being more adaptable to areas with feed shortage and in adequate water supply especially during the dry season which is a characteristic feature in semi-arid areas. This was consistent with what was reported by (El-Nouty *et al.,* 1990) that indigenous goats in the Kingdom of Saudi Arabia (SA) were adaptable to low feed intake, harsh environmental conditions and limited water resources. Similarly,

(Okeyo, 1997) reported that majority of exotic dairy goat breeds in Kenya are found mainly in the high and medium potential rainfall areas.

There was relationship between the type of breed kept and the levels of milk it produced within the same conditions like what was reported by (Güney *et al*., 2006) and (Norris *et al*., 2011) that different goat breeds produce different quantities of milk under the same ecological set up. This was in agreement with (Bosman *et al*., 1997) and (Kosgey *et al*., 2006) who reported that milk production by indigenous goats was between 0.3-0.5 litres per day while that of exotic goats was 1.5 to 2 litres per day. This production varies with the level management and climatic condition.

5.3 Management factors and how it affects milk production of different goat breeds

5.3.1 Feeding management

Feeding management activities considered during the study were, pasture and fodder establishment, feed supplementation and water management. The type of pasture established by farmers was found to have no effects on milk production. Farmers especially in sub humid areas established mainly grasses (boma Rhodes) which are less preferred to browse. This was contrary to (Muriuki, 2003) that increasing Napier yields substantially increases milk yields in dairy cows and (Lusweti *et al*., 2005), that fodder production techniques must be adopted as coping strategy of addressing feed shortages during the dry season in Kenya. The frequency of feed supplementation increased milk production levels in goats. However, the type of feed supplement and time of supplementing did not have any effects. This was consistent with (Leng, 2003) that supplementing goats frequently with different types of feed supplements especially leguminous tree leaves boosts milk production. Similarly (Kabirizi, 2013) found that adding 1 kg of calliandra daily to a diet of Napier, lablab and homemade concentrate increased the daily milk production of a cow by 0.7 litres. The insignificant effects of feed supplementation among indigenous goats as reported by farmers could probably be

attributed to low percentage of farmers who have engaged themselves in establishment of fodder legumes in semi-arid zone which has higher indigenous goat population

The frequency of watering, sources of water and distances to watering were found to affect milk production by both exotic and indigenous goats. Long trekking distances due to poorly distributed water points increased the energy requirements by goats and thereby reducing productivity. The study found that that increasing water sources decreased distances to watering points and increased frequency of watering thereby increasing milk production. This is consistent with (Salem and Smith, 2008) who observed that water availability is a serious constraint to flock survival during drought, especially to lactating does. Similarly (Salleh *et al*, 2010), found that supplementing goats with essential vitamins, probiotics, minerals and providing fresh water *ad libitum* increased meat and milk production in goats.

5.3.2 Housing management

The study found that both exotic and indigenous goats were housed and that housing affected milk production. Similarly (Alvarez and Gutierrez, 2010) noted that goat housing has been practiced by farmers since time in memorial though not all goats are housed. The design of houses can have influence on diseases and stress environment of the goats. This was consistent with (Nordmann *et al.*, 2011) who revealed that proper goat housing design can help mitigate individual aggressiveness of dairy goats and increase milk production. The type of goat house and the frequency of cleaning were found to affect milk production probably due to reduction of housing management related diseases and pests such as pneumonia, orf, flea and lice among others. Similarly (Mohd and Yogendran, 2009) found that the problem of low milk production by purebred goats could be improved by separating them from heat stress and tropical disease load by housing them in hygienic and climate-controlled houses. Similarly, (Olechnowicz and Jaskowski, 2011) reported that lameness was a high-risk factor for housed goats due to feet being consistently wet in excreta with bacteria. The waste cleaned from goat's house is essential soil fertility enhancer and can be used to improve crop production thereby

improving food security. This is consistent with (Juma and Ciamarra, 2013) who reported that in systems where farmers cut and carry forage for their goats, goat manure can easily be collected and spread onto vegetable gardens or in nearby fields, increasing soil organic matter and fertility**.**

5.3.3 Disease management

The study found that there was high prevalence of common diseases which not only reduced milk production but also meat production and damages skins of goats. Farmers within the study area used drenching and dipping to prevent and control both internal and external parasites. This was consistent to (Hoste and Torres-Acosta, 2011) who found that helminthes infection is a major concern for intensively pastured dairy goats. Likewise (Phillips *et al.,* 2009), noted that parasite control was rated by stakeholders of goat industry in Australia as one of the most serious welfare concerns. Similarly (Abud and Stubbs, 2009) reported that goat diseases like clostridia diseases, caprine arthritis encephalitis (CAE), caseous lymphadenitis (CLA), Johne's disease, and internal parasites affect dairy goat industry and are responsible for substantial production losses. High frequency of drenching was a sign that there was high infestation of worms which together with low feed availability causes increased emaciation and can lead to low conception rate and still births. Likewise (Besier and Love, 2002) reported that the control of gastrointestinal parasites needs to adopt a more strategic approach that involves the integration of control measures that will reduce reliance on anthelmintics and slow the development of anthelmintic resistance.

High frequency of spraying was reported and was noted as a good sign of high infestation of ecto parasites (fleas and mites) which increases kid mortality and even death to mature goats. This was similar to (McLeod, 1995) who reported that parasitic infections are regarded as the most prevalent health problem of grazing ruminants in Australia, with losses associated with nematodes, and ecto parasites causing a combined annual loss of approximately a billion dollars.

5.3.4 Breeding management

The study looked at five forms of breeding management techniques (culling, castration, selection, buck rotation and buck exchange) to see how they affected milk production levels. Only buck rotation and exchange was found affect production in both categories of goats. Castration was found to affect milk production in exotic goats. Similarly, (Thongchumroon *et al.,* 2011) reported that strategies on breeding for dairy goat production and management practices should be integrated with traditional farming practices in order to improve the performance of locally adapted breeds.

Buck rotation and buck exchange should be maintained to ensure that there is no inbreeding among the goats. Proper buck selection should be done by looking at phenotypic characteristics such as the testis, penis, horns, jaws, feet and skin colour. Genetic characteristics can only be assessed by looking at the performance of both parents on characters like milk production, birth rate, twining rate and susceptibility to diseases among others. This is consistent with (Kerketta *et al.,* 2012) that for a successful functional breeding soundness examination system, it should incorporate libido test scores, body conformation or testicular traits evaluation.

5.4 Social and economic factors influencing dairy goat milk production

5.4.1 Social factors

5.4.1.1 Literacy levels

The interaction of the various social factors influenced milk production for exotic and indigenous goats within the study area. From the study, it was revealed that most of the respondents had only basic education which under the Kenyan education system does not equip the learners with enough skills in farming. Though according to (Senyolo, 2007), education is a fundamental factor that enables farmers to easily communicate and understand farming business and be able to interpret market information, farmers within the study area lacked sufficient skills on farming. Low education level has been known to be a major challenge to livestock farmers especially where technologies are

sophisticated. The farmers are not able to understand and apply these technologies which have direct impact on productivity. Findings by (Ntege-Nanyeenya *et al.,* 1997) found that exposure to education may increase the capacity of the farmers to apply a given technology and hence improve production. Like wise (Demircan *et al.,* 2010) noted that there was a positive correlation between education and efficiency of goat production. Similarly, (Caswell *et al.,* 2001) reported that education creates a favorable mental attitude for the acceptance of new practices in agriculture which in turn improve productivity. In addition, (Wozniak, 1984) reported a positive significant relationship between education and adoption of technologies.

5.4.1.2 Experience

Most of the farmers who had more years in dairy goat keeping reported more milk production levels than those with fewer years. This was because they were capable of coping with challenges related to diseases, feeding, housing, breeding and marketing among others. This was consistent with (Makokha *et al.,* 2008) who revealed that dairy farmers use their experience in dairying to control the risks associated with dairying and have better control of diseases and management of dairy cattle. Likewise (Juma and Ciamarra, 2013) reported that personal experience was a source of knowledge to 18% of dairy goat farmers in Zanzibar. Older farmers have more experience in farming and are better able to assess the characteristics of modern technology than younger farmers (Adesina and Forson, 1995). Farmers with little experience will shy off from new technologies which is a breakthrough for early adopters. Similarly, (Kinambuga 2010) reported that experienced farmers had better skills of management of dairy animals and forage to improve production. (Doss and Morris, 2001) reported that age determines experience of an adopter of a technology and older farmers use their wealth of experience in making decisions in adopting an innovation. Farmers who had more experience in goat keeping had higher production efficiency scores than those with less experience (Gül *et al.,* 2016).

5.4.1.3 Affiliation to self-help group

The study found that those farmers who were organized in groups produced more milk than those who were not. This is because when farmers are organized into self-help groups they have one voice in procuring inputs and sourcing market for their produce thus enhancing improved productivity. This was in line with (Wakhungu *et al*., 2007) who noted that the co-operative concept allows dairy farmers to benefit from farm inputs, credit or market for the milk produce. Farmers can also be easily accessed by development agent especially where there are new innovations which need to be transferred. This allows them to maximize on profits and increase returns from their enterprise. Participation in learning activities related to fodder shrubs, often through groups, lead to successful uptake and increased production (Wambugu *et al.,* 2003). Similarly, (Maina, 2009) suggested that membership in community groups using a certain technology was likely to lead to better adoption of the technologies by more farmers and translate into other advantages.

5.4.2 Economic factors

5.4.2.1 Household income

Different households were found to have different per capita income levels depending on their types and sources of income. Those households which had high per capita earnings reported high milk production levels than those with low earnings. This could be linked to their capacity to adopt new technologies related to dairy goat production such as proper housing, pasture improvement, feed supplementation, disease control and purchase of high quality breeding stock which in turn improves milk production. This is consistent with (Diagne and Zeller, 2001) who reported that poor rural households in developing countries lack adequate access to credit which in turn impinges a significant negative impact on technology adoption, agricultural productivity, nutrition, health, and overall household welfare. Households with low income are disadvantaged because they constrain to access technologies which require money. This is consistent with (Mamudu

et al., 2012) who noted that younger farmers may not be able improve production since they cannot adopt modern capital intensive agricultural technologies, due to inadequate resources.

5.4.2.2 Household income sources

The study established that there was a relationship between the household income sources and milk production levels. Households which had other income sources apart from farming reported higher milk production levels. This could be related to complementary funds which can be used in purchasing feed supplement, breeding material, drugs and other inputs. This was contrary to (Gould *et al.,* 1989) who revealed that increasing involvement in off-farm employment for income generation reduced production performance.

To cut cost of production, goats can be taken care by engaging family members, especially children and women (Qureshi, 2011). In low-income countries, public funds have high opportunity costs, which make expenditures on goat keeping difficult to justify on the grounds of cost-effectiveness (Chen and Ravallion, 2008). Similarly, Makkar, 2007) noted that, key developments in goat enterprise can boost income of resource-poor goat keepers and take them out of poverty.

5.4.2.3 Availability and access to credit facilities

The study found that availability and accessibility to credit facilities by dairy goat keepers within the study area influenced milk production levels. This is because credit accessed could be used to facilitate adoption of technologies such as feeding, disease control, and breeding management which may require high capital. This is consistent with (Nguthi, 2007) who noted that credit or savings are often required to finance the inputs associated with a new technology. Similarly, (Wakhungu *et al*., 2007) reported that the co-operative concept allows dairy farmers to benefit from farm inputs, credit or market for the milk produce just like (Mamudu *et al*., 2012) who reported that lack of access to credit made it difficult for farmers to afford capital-intensive technologies.

Farmers who are skeptical and poor risk takers will not accept to access credits even if they are available. Farmers within the study area have a long history of fear of credit facilities. This does not concur with (Senyolo, 2007) who reported that farmers cannot access credit facilities to finance their different projects because of the unavailability of formal credit institutions in rural environments where they reside and carry out their agricultural activities.

5.5 The role of dairy goat keeping towards improvement of rural livelihoods

5.5.1 Improved levels of income

The study revealed that income of the farmers was improved through goat keeping. Those respondents who earned more from goat keeping said it was important to keep goats to improve income. This was consistent with (Peacock, 1996) who reported that goats provide a broad range of products and socio-economic services and play an important role in the social life of many people being used as gifts, dowry, religious rituals and rites of passage. It was also consistent with (Santos Junior *et al.,* 2008) who reported that income share of dairy goat husbandry was approximately 42% of total income in Brazil. Similarly, (Juma and Ciamarra, 2013) reported that farmers in Zanzibar are focusing on sell of live goats and that goat milk has the potential to provide significant economic benefits to farmers, as long as markets are accessible. Keeping goats lowered financial risks and overcame periods of cash shortage (Gihad and El-Bedawy, 2000). Similarly (Acharya, 1982) reported that in rural areas of India, goat farming plays a vital role in providing gainful employment to the economically backward communities and resource poor farmers.

A higher percentage of respondents said they frequently used the income from goat to purchase food and pay school fees. This could be interpreted to mean that majority of farmers were still poor. This is consistent with (Kosgey *et al.,* 2008) who established that income raised from goat farming was used as follows: fees (32%) purchase of food (22%), farm investment (18%), medical expenses (10%), off-farm investment (9%),

social activities (5%) and restocking (4%). Animal products constitute the main sources of nutrition for low-income farms (Dellal *et al.,* 2002). Farmers had a tendency to rear dairy goats for generation of savings and security against emergencies requiring quick cash, and/ or asset protection (Ogola *et al.,* 2010).

5.5.2 Improvement of nutritional levels

There was a relationship between dairy goat milk production and improved nutrition of farmers within the study area. The study found that majority of respondents who produced more milk per day used some it to feed children, old and all family members before making any further decision to sell it. This was consistent with (Acharya, 1982) and (Anon, 2012) that goats supply precious animal proteins of high biological value in the form of meat, milk, plus essential minerals and fat- borne vitamins to poor people, pregnant mothers and young children. Similarly, (Shivairo *et al.,* 2013) noted that 60.3% of the dairy goat smallholder households in Kenya consumed goat milk indicating an increasing value of the dairy goat milk in their diet.

On milk preference, the study found that goat milk was more preferred to cow's milk since majority of respondents agreed that it had high solids and good flavour than cow's milk. This was consistent with (Ochepo and Momoh, 2010), (Gurmesa *et al*., 2011) and (Ozung *et al*., 2011) who reported that goat milk had a high medicinal value because of high proportion of short and medium chain fatty acids with smaller globules which makes it suitable for relieving stress, constipation, and curing migraine and asthma.

5.5.3 Soil fertility improvement

The study established that goat keeping increased crop yields through improved soil fertility. Majority of the respondents who used farm yard manure in their farms reported high soil fertility of their farms. This was consistent with (Ogola *et al.,* 2010) who found that 76.8% farmers did not buy inorganic fertilizer, but used manure in their farms to increase crop yields and similar to (Onim, 1992) who observed that manure had a positive environmental effect when used on either crop land or fodder.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The study showed that the households sizes were less five members mainly head by men who had basic primary education and owners of production resources. Semi-arid zone generally received less rainfall than sub humid zone which affected pasture and fodder production especially during the dry period. Exotic goats were more preferred in the sub humid part. Small farm sizes and over utilization of them resulted in poor soil fertility of farms in sub humid part of the study area.

Feed supplementation, watering, and housing were a common practice among goat keepers. Drenching and dipping was found to be the common modes of diseases prevention while buck rotation and exchange were the best ways of controlling inbreeding within the study area. Level of education, experience and membership to self-help groups impacted on milk production levels. Household income from farming and other sources, availability and accessibility of credit facilities increased milk production levels within the study area. Utilization of farm yard manure within the farms improved crop and pasture yields and hence improving food security.

The study showed that dairy goat keeping improved the livelihood and living standards of the households through increased income levels and improved nutrition.

6.2 Recommendations

- Application of proper water harvesting techniques and adoption of drought tolerant pasture and fodder seeds will help mitigate against disasters caused by inadequate rainfall

- Capacity building farmers on proper animal husbandry practices will lead to adoption of new technologies on pasture and feed management, housing and disease management to improve milk production.

- Sensitizing farmers to come together in self-help groups, CBOs and even cooperatives so as to have a common bargaining power when it comes to marketing of their products and purchasing farm inputs. It will also assist them in accessing credit facilities

- Provide funds to carry out more research of dairy goat keeping and other landless production enterprises since the population is increasing and the land is shrinking.

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APPENDICES

Appendix 1: Introductory letter

MR. STEPHEN MUTUKU MUSYOKA

P.O BOX 231, KIRITIRI - EMBU KENYA

PHONE: 0721568567

Dear Sir/Madam

RE: REQUEST TO FILL QUESTIONNARES FOR RESEARCH PURPOSE

I am a post graduate student at South Eastern Kenya University, department of Range and wildlife sciences and i am carrying out a research factors influencing dairy goat milk production Kitui Township, Kyangwithya east and west wards of Kitui Central Sub – County

The information gathered will be treated as confidential and will be for the sole purpose of this study. Kindly respond to the items in the attached questionnaires to the best of your knowledge

Thank you

STEPHEN MUTUKU MUSYOKA

Appendix 2: Consent form

FACTORS INFLUENCING DAIRY GOAT MILK PRODUCTION IN KITUI TOWNSHIP, KYANGWITYA EAST AND WEST WARDS OF KITUI CENTRAL SUB-COUNTY

INVESTIGATOR: MR. STEPHEN MUTUKU MUSYOKA

P.O BOX 231, KIRITIRI - EMBU KENYA.

I ……of P.O BOX……

Telephone……hereby give informed consent to participate in this study in Kitui Central. The study has been explained to me clearly by the data collector. I have understood that to participate in this study, I shall volunteer any information about the dairy goat farming in Kitui Township, Kyangwithya east and west wards of Kitui Central sub-county. I am aware that I can withdraw from this study anytime without any prejudice. I have been assured that this is not an exam and that the questionnaire is only for academic reasons. There will be no direct benefit from my participation in this study. However, the findings on the study will be beneficial to the CBO's, county governments and any other interested person(s) in dairy goat keeping.

Name of participant……

Signature……

Date …….

Name of the data collector …….....

Appendix 3: Study area

The nine (9) sub locations where the study was carried are Mulundi, Museve, Mutune and Misewani in (sub humid area) and Kaveta, Kalundu, Mulutu, Mbusyani, and Tungutu in (semi-arid area) where intervention was initiated by kitui agricultural project (KAP), Farm Africa, Arid lands resource management project (ALRMPII), Catholic diocese of Kitui (CDK), and kitui development centre (KDC).

Sub county/ constituency	**Wards**	**Sublocation**	**Ecological zone**	**Population**	**Households**	**Area in Km^2**	**Population Density**
Kitui central	Township	Kalundu	Semi-arid	4180	1141	2.42	1730.28
Kitui central	Kyangwithya West	Kaveta	Semi-arid	4584	800	8.27	554.02
Kitui central	Kyangwithya West	Mbusyani	Semi-arid	1662	321	7.4	224.46
Kitui central	Kyangwithya East	Misewani	Sub humid	5719	1148	9.59	596.64
Kitui central	Kyangwithya East	Mulundi	Sub humid	6899	1159	24.42	282.52
Kitui central	Kyangwithya West	Mulutu	Semi-arid	3848	615	28.45	135.24
Kitui central	Kyangwithya East	Museve	Sub humid	6374	1197	41.52	153.53

Kitui central	Kyangwithya East	Mutune	Sub humid	4778	710	10.84	440.84
Kitui central	Kyangwithya West	Tungutu	Semi-arid	6778	1021	20.77	326.38
Total				**44822**	**8112**	**153.68**	**4443.91**

Appendix 4: Questionnaire

FACTORS INFLUENCING DAIRY GOAT MILK PRODUCTION IN KITUI TOWNSHIP, KYANGWITYA EAST AND WEST WARDS OF KITUI CENTRAL SUB-COUNTY

SOUTH EASTERN KENYA UNIVERSITY

School of Agriculture and Veterinary Sciences

Kitui campus

Name of the Enumerator…….
Date of interview…….
Name of administrative district……..
Ward…….
Name of location……..
Name of sub location……
Name of village……

I. PERSONAL INFORMATION

NAME OF RESPONDENT ……

CONTACT INFORMATION: (Mobile No) ……

II. HOUSEHOLD PROFILE

1. Name of the household head (key decision maker): ……
2. Size of the household (members living with you): ……
3. Gender of household head: (Please tick as appropriate)

Male.	
Female	

4. Age in years of household head (Please tick as appropriate)

20-29years	30-39years.	40-49years	>50years

5. Marital Status of household head (Please tick as appropriate)

Single/ Never married.	Married	Widowed	Separated /Divorced

6. Level of education of household head (Please tick as appropriate)

None	Primary	Secondary	Tertiary/college

7. What are the sources of income in the household (Please tick as appropriate)

Employment	Pension	Selling of livestock	Selling of crop produce	Petty trade	Casual labour wage	Remittances from children/ friends

8. What is estimated income of the household per month? (Tick appropriately)

<500	500 – 1000	1001 – 2000	2001 – 3000	3001 – 5000	>5000

III. MILK PRODUCTION UNDER DIFFERENT ECOLOGICAL CONDITIONS

1. Do you keep goats? (Tick where appropriate)

Yes	No

If yes

(a) What type do you keep? (Tick where appropriate)

1. Alpine
2. Toggenburg
3. Small east African goat
4. Galla goats
5. Crosses

(b) How much milk do you get from each category per day? (Tick where appropriate)

Alpine	<1 litre	1.1 – 2 litres	2.1 – 3 litres	3 litres
Toggenburg				
SEAG (Small East African Goat)				
Galla				
Crosses				

(c) How many do you have per category? (Tick where appropriate)

Type	1 – 3	4 – 5	6 – 10	>10
Alpine				
Toggenburg				
SEAG (Small East African Goat)				
Galla				
Crosses				

(d) How much goat milk do you use per day? (Tick where appropriate)

Use	<0.5litre	0.5 – 1 litre	>1 litre
Home consumption by children and the old			

Home consumption by all family members			
Sale to neighbor			
Sale to trader			

2. In your own view, estimated the amount of rainfall per season? (Fill appropriately and quote the source)

Season / Average	March – April rains	November – December rains
High		
Moderate		
Low		

3. Is it sufficient for fodder production? (Tick where appropriate)

Yes	
No	

4. In your own view, how are the daily temperatures in your area? (Fill appropriately and quote the source)

Average	Amount in °c	Source
Low		
Moderate		
High		

5. What is your land endowment and use (Insert as appropriate)?

	Area(Acres)	**Production goal**	**Land acquisition**
Total area(Acres)	a. <2 acres b. 2 – 5 acres c. 6 – 10 acres d. >10 acres	a. Subsistence b. Commercial c. Both	a. Inherited b. Purchased c. Hired d. Others (specify)
Land under livestock			
Land under exotic goats			
Land under indigenous/ local goats			
Land under crop production			

6. Where do you take fecal waste from your livestock? (Tick where appropriate)

Use them in my farm	
Sell them	
Give it to my friends	
Others(Specify)	

7. If you sell it how much does it cost? (Indicate the cost per appropriate measure)

Measure	**Amount (Ksh)**
Wheelbarrow	
Cart	
Lorry	

8. Do you have planted pasture (fodder)? (Tick where appropriate)

Yes	
No	

9. Which one, where and how much do they cost? (Indicate appropriately)

Material	**Source**	**Amount(Ksh) per Kgs**
Boma rhodes		
Nappier grass		
Leucena		
Lucern		
Potatoe vines		
Others specify		

IV. MILK PRODUCTION UNDER DIFFERENT MANAGEMENT SYSTEMS.

1. Under which grazing system do you keep your dairy goats? (Tick appropriately)

Grazing system	
Zero grazing	
Semi zero grazing	
Tethering	
Free range grazing	

2. Why do you keep them under this system of grazing?

……

……

……

Do you supplement them?

Yes	No

If no why? (Tick as appropriate)

Lack of money to buy them	
Not available in the market (No stockiest)	
Don't see the need	
Have no information	

If yes when do you supplement them?

When pregnant	When milking	During service	Throughout the year

3. What type and cost of feed supplements do you give your goats? (Tick appropriately)

Type	**Tick where applicable**	**Cost per month(Ksh)**
Dairy meal		
Mineral blocks		
Accacia pods		
Others (specify)		

4. How often do you water your dairy goats? (Tick as appropriate)

Daily	Thrice per week	Twice per week	Others (specify)

5. What is the source of your water? (Tick as appropriate)

Piped water	Shallow well	River bed wells	Boreholes

6. What are the distances to watering point? (Tick where appropriate)

Distance	
<0.5 Km	
0.5 – 1 Km	
>1 Km	

7. Do you house you dairy goat? (Tick where appropriate)

Yes	No

8. How have you housed your goats? (tick as appropriate)

Grass thatched ground level house	
Iron sheet roofed ground level house	
Grass thatched stilted(raised) house	
Iron sheet roofed stilted(raised) house	
Boma, Kraal (fenced with local thorn trees)	
Others(specify)	

9. How often do you clean your dairy goat house per week? (Tick as appropriate)

Daily	Once	Twice	Other (specify)

10. What are the common goat diseases in your village? (Tick where appropriate)

Common goat diseases	
Worm infestation	
Pneumonia	
CCPP	
Anaplasmosis	
Diarrhea	
Ecto parasites (ticks, fleas, mites)	
Mastitis	
Orf	
Abscess	

11. Rank the diseases in order frequency (Tick where appropriate)

1. Very frequent.
2. Frequent.
3. Not Frequent

Disease	**Frequency**
Worm infestation	
Pneumonia	
CCPP	
Anaplasmosis	

Diarrhea	
Ecto parasites (ticks, fleas, mites)	
Mastitis	
Orf	
Abscess	

12. How do you prevent you goats from diseases? (Tick as appropriate)

Vaccination	
Tick control	
Worm control	
Treatment	
Others (Specify)	

13. How often do you vaccinate your dairy goats? (Tick as appropriate)

None	Once per year	After 6 months	As per vaccination regime

14. How often do spray or dip your dairy goats? (Tick as appropriate)

None	Once per week	Twice per week	Thrice per week	Others(Specify)

15. How often do you drench your dairy goats? (Tick as appropriate)

None	After every two months	After every three months	Other (Specify)

16. What is the cost per category? (Indicate appropriately)

Category	**Cost per year(Ksh)**
Vaccination	
Tick control	
Worm control	
Treatment	

17. Where do you get veterinary services once your dairy goats are sick? (Tick appropriately)

Government employed veterinary officers	
Retired veterinary officers	
Private veterinary officers	
Community based animal health workers (paravets)	
Un trained practiced fellow farmers	
Others(specify)	

18. Where do you get extension services on dairy goats? (Tick appropriately)

Government employed extension officers	
Retired extension officers	
Private extension officers	
Fellow farmers	

Internet	
Electronic Media (radio, television)	
Other (Specify)	

19. Who is in involved in the management of dairy goats in your household? (Tick as appropriate)

Men	
Women	
Children	
All	

20. How did you acquire your goats? (Tick where appropriate)

	Own purchase	NGO	Government	Group exchange	Others(specify)
Exotic					
Indigenous					
Crosses					

21. How much did one goat cost? (Tick where appropriate)

Type	<5000	5000 – 8000	8001 – 12000	>12000	Given free
Alpine					
Toggenburg					
SEAG (small east africa goat)					
Galla					
Crossess					

22. Are your aware of inbreeding? (Tick where appropriate)

Yes	
No	

If yes, how do you control it? (Tick where appropriate)

Control	
Castration	
Culling/ selling unwanted bucks	
Buck exchange	
Buck rotation	
Other(specify)	

23. How do you dispose your unwanted breeding material? (Tick where appropriate)

Disposal	Selling as breeding material	Selling to the market	Slaughter	Exchanging it with another animal
Alpines				
Toggenburgs				
SEAG/Local				
Galla				
Crosses				

24. What is the cost for each category? (Indicate appropriately)

Disposal	Selling as breeding	Selling to the market	Slaughter	Exchanging it with another animal
Cost per animal in (Ksh)	Cost/Animal	Cost/Animal	Cost/Animal	Cost/Animal
Alpines				
Toggenburgs				
SEAG/Local				
Galla				
Crosses				

25. Are there any credit facilities in the sub county? (Tick where appropriate)

Yes	
No	

26. If yes, do the farmers access them to purchase dairy goats? (Tick where appropriate)

Yes	
No	

27. If no why? (Tick where appropriate)

Dairy goat keeping is not profitable	
Farmers fear getting loans	
Both of the above	

28. Estimate the number households in your village who keep dairy goats? (Tick appropriately)

None	1 – 5	6– 10	>10

29. Do you expect the number of these households to increase or decrease? (Tick appropriately)

Increase	
Decrease	

V. SOCIAL AND ECONOMIC FACTORS INFLUENCING DAIRY GOAT MILK PRODUCTION.

1. Why do you keep goats? (Rank them in order of importance)

0 = Not important

1 = Important

2 = Very important

Milk	
Meat	
Manure	
Sale of offspring and cull for money	
Prestige/ dowry	

For leisure or as by the way	

2. What cost do you incur on raising dairy goat?

Item	**Price per month**	**Price per year**
Drugs		
Dipping / spraying		
Labour cost		
Feed costs (concentrate)		
Mineral block		
Hiring breeding male		
Construction cost		
Goat house repair cost		
Veterinary/extension services		
Total costs		

3. On average, how much income per month do you get from sales of these goat products

Product	<500	501 - 1000	1001 – 2000	2001 – 3000	>3000
Milk					

Sale of breeding and culls					
Manure					
Sale in butchery as meat					

4. How is this income used? (Rank them as)
   1. Very frequent
   2. Frequently
   3. Not frequent

Purchase of food	
Purchase of clothing	
Paying of school fees	
Purchase of drugs/ medical bills	
Others(specify)	

5. Income from other sales of livestock and their products (for last 12 months)

Type	Number	Income from sales	Costs	
			Feeds	Drugs
i)Cattle - Milk - Live animal				

ii)Chicken - Eggs - Live chicken				
iv) Sheep				
v) (other specify)				

VI. THE ROLE OF DAIRY GOAT FARMING TOWARDS IMPROVEMENT OF RURAL LIVELIHOODS.

1. What is the perception of the community members on consumption of dairy goat milk? (Tick where appropriate)

   (i)Positive (Accept it).

   (ii)Negative (Reject it).

   (iii)Don't know.

2. In your own words, what do you think is the effect of the perception?

……

……

……

3. Compared to cow milk, which one is more preferred

Goats	Cows	Don't know

4. Why it is more preferred? (Rank them in order of priority)

   1= strongly agree 3= Disagree

   2= Agree 4= strongly disagree

High in solids	
Low odour	
Good flavour	

5. What are the challenges in dairy goat keeping?

   ……

   ……

6. In your own view, do you think that dairy goat keeping is profitable? (Tick appropriately)

   a) Highly profitable
   b) Profitable
   c) Lowly profitable
   d) Not profitable

7. What would you recommend to government and other development agents in the sub county? (Tick where appropriate)

Invest more in the dairy goat industry	
Maintain status quo	
Stop investing in the dairy goat industry	

"Thank you for the time and cooperation"

Appendix 5: Prevalence of common exotic goat diseases/ pests

Disease/ pest		**Amount of milk from exotic goat**			
		< 2litres	**>2 litres**		
Worm infestation	Frequent	100.0%	17.9%	64.934	0.000
	Not frequent	0.0%	82.1%		
Pneumonia	Frequent	100.0%	17.9%	64.934	0.000
	Not frequent	0.0%	82.1%		
CCPP	Frequent	29.4%	30.8%	0.019	0.889
	Not frequent	70.6%	69.2%		
Anaplasmosis	Frequent	98.0%	17.9%	61.045	0.000
	Not frequent	3.0%	97.0%		
Diarrhea	Frequent	58.8%	46.2%	1.425	0.233
	Not frequent	41.2%	53.8%		
Ecto parasites	Frequent	100.0%	15.4%	68.138	0.000
	Not frequent	0.0%	84.6%		
Mastitis	Frequent	13.7%	7.7%	0.814	0.367
	Not frequent	86.3%	92.3%		
Orf	Frequent	45.1%	41.0%	0.149	0.699

	Not frequent	54.9%	59.0%		
Abscess	Frequent	13.7%	17.9%	0.300	0.584
	Not frequent	86.3%	82.1%		

Appendix 6: Prevalence of common indigenous goat diseases/pests

Disease/ pest		**Amount of milk from indigenous goat**			
		< 1litre	**>1 litre**		
Worm infestation	Frequent	94.4%	19.4%	53.025	0.000
	Not frequent	5.6%	80.6%		
Pneumonia	Frequent	94.4%	19.4%	53.025	0.000
	Not frequent	5.6%	80.6%		
CCPP	Frequent	31.5%	27.8%	0.141	0.707
	Not frequent	68.5%	72.2%		
Anaplasmosis	Frequent	92.6%	19.4%	49.769	0.000
	Not frequent	7.4%	80.6%		
Diarrhea	Frequent	61.1%	41.7%	3.281	0.070
	Not frequent	38.9%	58.3%		
Ecto parasites	Frequent	96.3%	13.9%	63.166	0.000
	Not frequent	3.7%	86.1%		
Mastitis	Frequent	13.0%	8.3%	0.469	0.494
	Not frequent	87.0%	91.7%		
Orf	Frequent	42.6%	44.4%	0.030	0.862

	Not frequent	57.4%	55.6%		
Abscess	Frequent	13.0%	19.4%	0.691	0.406
	Not frequent	87.0%	80.6%		

Appendix7: Published article

The Socio - Economic Factors Influencing Dairy Goat Milk Production in Kitui Township, Kyangwithya East and Kyangwithya West Wards Of Kitui Central Sub County – Kenya

Stephen M. Musyoka[1*], Titus I. Kanui[2*], Simon Nguluu[3*], Stephen Wambua[4*] and Alphaxard Ndathi[5*]

[1] Ministry of Agriculture, livestock and fisheries development, Mbeere south – Embu County

[2]Department of Range and Wildlife Sciences, Faculty of agriculture and veterinary sciences South Eastern Kenya University

[3]Department of Dry Land Agriculture, Faculty of agriculture and veterinary sciences South Eastern Kenya University

[4]Department of Agricultural economics and agribusiness, Faculty of agriculture and veterinary sciences South Eastern Kenya University

[5]Department of Range and Wildlife Sciences, Faculty of agriculture and veterinary sciences South Eastern Kenya University

A study was carried out in Kitui Township, Kyangwithya east and Kyangwithya west wards of Kitui central sub county to assess the socio - economic factors influencing dairy goat milk production. Both exotic and indigenous goats were surveyed. Multi stage and purposive sampling techniques were used to select 90 households from two agro ecological zones (semi-arid and sub humid) within the wards. Social and economic factors analyzed were education, experience, affiliation to groups, household income, income sources, availability and accessibility of credit facilities. Both the social and economic factors were found to have significant ($p<0.05$) effects to milk production across the two breeds. It was concluded that when farmers are organized into self-help groups, they can mitigate against challenges related to limited resources like land, water, labour, finances, skills, knowledge and marketing.

Key words: Goat keeping, Milk production, Credit facilities, Farmer groups, Experience, Education

Appendix 8: Approval

APPROVED FOR ISSUE

VICE CHANCELLOR_____

SIGNATURE_____

DATE: _____