INFLUENCE OF DAIRY FARMING PRACTICES ON MILK PRODUCTION IN KENYA: A CASE OF GITHUNGURI CONSTITUENCY, KIAMBU COUNTY

BY

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DECLARATION

This research project report is my original work and has not been presented for award of any degree or any other University.

Signed …… Date ……

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This research project report has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

I dedicate this work to my children Austin Gakuu and Anita Muthoni who are the pillars of my life and the reason I get the motivation of working hard in life. To my dad Mr. Patrick Kabecha whose love for education is great and pushed me hard enough to get to this level. To my husband Samson who has offered great support and encouraged me to go all the way. I wouldn't have done these without all of you and I thank God for you.

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ABBREVIATIONS AND ACRONYMS

GDFP	Good Dairy Farming Practices
FAOSTAT	Food and Agriculture Organization Statistics
IFCN	International Federation Of Clinical Neurophysiologists
NRC	National Research Council
SPSS	Statistical Package for Social Sciences
UK	United Kingdom

ABSTRACT

Despite the growth in dairy farming over the years, there is a lot of imbalance in milk production experienced in different areas based on the approach from different farmers. Majority of farmers still fail to understand the connection between dairy productivity and farming practices. Without careful analysis of the patterns of benefits reaped from good farming practices, we cannot accept at the face value that dairy farming can be both fulfilling and satisfying. The purpose of this study was to determine the influence of dairy farming practices on milk production in Githunguri Constituency, Kiambu County. The study sought to establish the extent to which dairy animal nutrition, animal health, animal hygiene, observance of animal welfare and socio-economic management influences milk production. The research design adopted in this research was descriptive survey. The target population of this study included10,136 dairy farmers in Githunguri Constituency. Stratified proportionate random sampling technique was used to select the sample. From each stratum the study used simple random sampling to select 384 respondents. A questionnaire with closed and open ended questions was used to obtain the data from the respondents. Qualitative data from the open ended questions was analyzed thematically by content analysis and the findings presented in prose. In order to effectively analyse the primary quantitative data, descriptive statistics including percentages, frequencies, means and standard deviation was used. Regression analysis was conducted to show the strength of the relationship between the dependent and independent variables. Presentation of quantitative data was done using frequency in tables and graphs. The findings were animal health, animal nutrition, animal hygiene, animal welfare to a very great extent influenced the level of milk production and that socio- economic management to a great extent influenced milk production. The study concluded that animal nutrition is essential to animal health which in turn influence the level of milk produced, animal health to a very great extent influence the level of milk production and use of suitable and well maintenance of milking and storage equipment, milking under hygienic conditions to prevent physical and microbiological contamination, practicing good milking routines and ensuring high cleanliness standards when handling the cows were aspects of animal hygiene that influence the level of milk production. Undergoing training on hygiene milk production and following good milking techniques also influence milk production. The study recommended that animal nutritionists or ministry of livestock devise strategies on how to reach the unable farmers who desire to expand in dairy farming but are frequently faced with problems related to nutrition. Most of them claim that they don't use chemical, toxin or prohibited ingredients but with animal nutritionist's help this may be false. The farmers should be trained on how to know the behavior of animals and their reaction to various circumstances as most of the lack these skills.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Dairy farming has been part of agriculture for thousands of years since the early days of man when he decided to start domesticating animals. Britain pioneered in dairy farming after the agrarian revolution which then spread to other parts of Europe and America during the scientific revolution in the 18th century. The industry then extended to the Balkan lands namely Denmark, Norway, Sweden, the Netherlands and ultimately to Africa through ancient Egypt. Historically it has been one part of small, diverse farms. In the last century or so larger farms doing only dairy production did emerge. In New Zealand dairy cattle were first imported by European settlers in the early 19th Century to provide milk, butter and cheese for local supply. As early as 1846, only six years after the signing of the Treaty of Waitangi, the first dairy exports to different parts of Europe began. In 1882 New Zealand exported the first refrigerated shipment - a worldwide first - of meat and butter from Port Chalmers, Dunedin to London on the ship "Dunedin" (Muchirii, 2007).

The 1930s to the 1960s saw the beginnings of the industry consolidation. As technologies in transport and refrigeration improved - for example, cooling of milk on-farm was introduced. By 1955 co-operatives began joining forces to become more efficient. By the 1960s, New Zealand's 400 co-operatives had become 168.By the 1980s, the New Zealand Dairy Board had 19 subsidiaries and associated companies around the world. By 1990 it had 40 and by 1995, 80. In a little more than 10 years, the New Zealand Dairy Board became the world's largest dedicated dairy marketing network (Staal and Pratt, 2001).

Since the 1960's dairy farming in The Netherlands has gone through a metamorphosis. The average number of cattle per farm has increased sevenfold: from 9 to 66 animals. Modern free roaming stables today can even keep up to 1000 animals. At the same time one man by 2007 produced 17 times the amount of milk that one man in 1960 produced (Ham, 2010).

In Africa milk producing animals have been domesticated for thousands of years. Initially, they were part of the subsistence farming that nomads engaged in. As the community moved about the country, their animals accompanied them. Protecting and feeding the animals were a big part of the symbiotic relationship between the animals and the herders. The industry has been growing gradually in Africa where traditional systems have dominated milk production

for several years and still supply considerable amounts of milk today accounting for above 90% of dairy ruminant population in Sub-saharan Africa (Olaloku and Debre 1992). Indigenous groups like the Maasai, Borani, Fulani and Tuareg have a strong historic dairy tradition. They share many customs and regard milk as a product of harmony that is offered free to relatives, friends and visitors (Bayé, 2000, Sadou, 2000 and Suttie, 2001). Due to population growth, land shortage and increasing interest in production and consumption, market-oriented dairy systems are now evolving, with the use of high performing graded animals and/or higher inputs. Several international bodies (Heifer Project International, Land O'Lakes, Send a Cow, etc.) have developed strategies to promote milk production in African countries. These bodies usually have two main objectives: Improving on milk consumption especially by poor families (nutrition improvement) and increasing on farm returns from dairy farming (income generation and poverty alleviation). Therefore, it is important to see how dairying has evolved in Africa as a whole and in individual African countries as well. The growth of the dairy industry between 1990 and 2004 saw the demand for milk and dairy products in Africa growing at an average rate of 4.0% per annum; meanwhile production only grew at a rate of 3.1%. Growth in consumption was pushed both by a growth in population (of 2.8% per annum) and a small growth in per capita milk consumption (of 0.8% per annum) between1990 and 2004 (FAOSTAT 2006; IFCN Sector model 2006).

In South Africa dairy farms were mainly founded in the Witwatersrand, Durban, Cape Peninsula and other large consumer areas prior to the 1950s. The reason for this is that land was relatively inexpensive. In those days cream farming was a comparatively low-cost activity, basically since farming was based on crop residues and natural veld with relatively minimal, if any, supplementary feeding. As time went by the milk production regions eventually shifted from inland to coastal grazing areas where the Boers settled. The country now boasts to be among the African powerhouses in dairy production(Staal and Pratt, 2001).

In Kenya one of the oldest pastoral systems was and is still practiced by the Maasai in the sparsely populated semi-arid range-lands. The Maasai are nomadic pastoralists who live in extended families of 10-15 people with herds averaging 100-170 cattle and as many sheep and goats. In this system, milk surplus is shared with neighbours or exchanged in barter, but is rarely sold except by households living close (<5 km) to main roads and urban centres where there is demand for fresh and fermented milk, and butter. The Borana pastoral system

is similar to that of the Maasai. Here, the frequency and amounts of dairy products traded depend on herd size and distance to the market. Milk sales in the Borana system is however of higher interest than is the case with the Maasai (De Leeuw et al 1998

There is the Semi-intensive system which is common in peri-urban zones, having farms which are owned by business men, civil servants and private individuals who employ labour in the catering of their animals, with milk production as their major objective (Diop and Mazouz, 1995). Here, there is use of graded cows or crossbreeds, usually between exotic bulls and local cows or through artificial insemination (AI). The aim of crossbreeding is to upgrade for better milk production and at the same time retaining the adaptability of the animals in changing environmental conditions (Bayemi 2005). In such farms where management is moderate, it is important for the animals to have a natural resistance to environmental stress. Milk production here is much higher than in pastoral systems, though still less than in graded cows.

The intensive system is characterized by an increased market infrastructure which consequently increases the importance of the dairy component in smallholder dairying. Increasing population growth and urbanization have led to the intensification of dairy systems around urban areas in Africa which is also favoured by a higher demand in such areas. The farms here are small (about 1-2 ha with 1-2 cows generally Holstein Friesian or Ayrshire). Feeding is mainly fodder from planted Napier grass *(Pennisetum purpureum)* and crop residues, especially from maize and bananas. Most work on majority of such dairy farms is done by the family. Contrary to pastoral systems where large proportions and sometimes all the daily milk is consumed at home, only a small portion of milk produced in this system is left for home consumption and the rest sold (De Leeuw, 1998).

Kenya has enjoyed 100 years of experience with exotic breeds of dairy cattle, while surrounding countries such as Ethiopia and Uganda have not. The resulting accessibility of improved cross-breeds, well established artificial insemination and veterinary services, and marketing infrastructure offer an important springboard on which smallholder farmers have been able to build. Other countries without this historic endowment of dairying expertise and facilities will likely face longer lead times in expanding smallholder dairy production (Muchirii, 2007).

Widespread introduction of highly productive breeds of dairy cows, or grade cattle, has been the major source of increased productivity in Kenyan dairying. Provision of efficient and affordable reproductive services has therefore remained a central pillar of the country's dairy development strategy. In the early decades following independence, from 1964 to 1987, government heavily subsidized artificial insemination services. Though expensive, this strategy did result in widespread adoption of improved breeds. This however must incorporate many other dairy farming practices to be successful (Ngigi, 2003).That is the reason as to why there is a higher market orientation in large intensive systems and more emphasis is laid on feeding and breeding management to assure optimal production (Diop, Mazouz, 1995). This has seen Kenya dairy industry grow where improved dairy cattle account for 23 percent of the total cattle population within the central highland as well as the Rift valley regions, and 75 percent of all specialized dairy cattle in Eastern and Southern Africa. In contrast, improved breeds account for only 3 percent of dairy cattle in Uganda and less than 1 percent of total cattle in Ethiopia.

Most of the breeds that are found in Kenya are mostly exotic which include Ayrshire which originated from Scotland; known for vigor and efficiency of milk production due to the quality of its udder. It is known to thrive well in the cold Kenyan highlands. Guernsey whose Origin is the English Channel, 30 miles off the coast of France. Her milk is yellow due to the butter fat content. She is hearty and adaptable (Muchirii, 2007).Jersey, whose origin is the island of Jersey 15 miles off the coast of France and is known to produce more butterfat in her milk than other dairy breed. Friesian, the biggest of the dairy cows, having originated from the Netherlands. She is the world's most popular dairy breed. It is famed with producing large quantities of milk.

Milk production in Kiambu County is mainly market-oriented and carried out by small scale dairy farmers (SDF), rearing exotic breeds of dairy cattle. European Settlers started the dairy enterprises in Kiambu County and introduced high yielding dairy cattle (Economic Survey, 2006). After independence, Kiambu SDF acquired exotic dairy cattle from the European settlers and set for dairy farming because there was ready market and the exotic breeds produced more milk for marketing to KCC which was the legal outlet of raw milk (Muriuki, 1991). Early 1992, the government of Kenya liberalized the milk market for SDF to commercialize the dairy industry but a "flood" of middlemen dominated Kiambu County

transporting the raw milk to Nairobi, the largest market for both raw milk and value added milk products in the country (Muriuki, 1991). Middlemen operate to make profits and soon both private processors and milk middlemen took the fullest and earliest advantage buying milk at the farm gate at the lowest price possible and commercializing milk sales after value addition at the expense of the farmers (Economic Survey, 2006).

Githunguri Constituency farmers experienced several challenges in dairy milk production. SDF in Githunguri had small land sizes which could not support dairy enterprise and commercial feed supplements had to be bought. The average size of land owned by SDF in Githunguri was small approximately 0.8ha, divided among the dairy enterprise, home area, crops such as cash crops, subsistence crops and livestock (MoLD, 2007). A SDF reared 4 dairy cows on average yielding about 10 liters each per day (MoLD, 2007). This meant that the scale of dairy enterprise operated by farmers was small. Fodder from the farm was then cut and ferried to the animals in zero grazing units because of shortage grazing land (Conelly, 1998). Permanent laborers had to be employed to manage livestock enterprise. The system of rearing dairy cattle thus proofed expensive. Income to the farmers was low because the private processors and milk middlemen stood between producer (farmer) and the consumers (MoLD, 2007). The price the farmer received at the farm gate and the price the consumer paid at the end of the value chain were different by a big margin. SDF on the other hand desired to raise more income from the raw milk produced to alleviate poverty. Government's policy directed that SDF add value to raw milk to ensure the middlemen paved way for farmers to engage in direct business with the consumers (MoA, 2009). However the situation on the ground was that the middlemen continued to dominate the milk market in Githunguri in numerous numbers, and SDF lamented exploitation by middlemen. Though their cooperative, Githunguri Dairy, their milk production is almost equivalent to that of North Rift. If all Kiambu constituencies are turned into Githunguri in terms of milk production, the county could produce more milk than the rest of Kenya combined.

1.2 Statement of the Problem

Milk production has really improved over the years with the embracing of different and modern milk production techniques. It is, however, observed that the farmers have not realized the optimal production of the same, and are thus operating below peak (Muriuki, 2002). It is, therefore, important to acknowledge that good dairy farming principles are vital

in attaining maximum milk production. An animal's health and productivity, along with the quality and safety of her milk are key though dependent on the quality and management of the feed and water. Animal welfare has been a primary concern as it deals with the well-being of the animal. In general, consumers perceive high animal welfare standards as an indicator that food is safe, healthy and of high quality. Increasingly, consumers are concerned that the production of food is being undertaken in harmony with the environment in respect to socio-economic management. To meet these concerns, it is important that farmers produce milk in a way that minimizes any damage to the environment.

Despite the growth in dairy farming over the years, there is a lot of imbalance experienced in different areas based on the approach from different farmers. Majority of farmers still fail to understand the connection between dairy productivity and farming practices. Without careful analysis of the patterns of benefits that can be reaped from good farming practices, we cannot accept at the face value that dairy farming can be both fulfilling and satisfying (Muchirii, 2007).

One of the major problems among the farmers is the choice of feeds they give their dairy animals. Some of the feeds do not have the right nutrients capable of boosting milk quality and quantity. Most of the farmers do not extend any meaningful consideration to the type of feeds and they deal with the same feeds all year round. This is coupled by ignorance to animal health where farmers take a lot of time or ignore administration of healthcare to animals even after changes in weather (MoLD, 2007).

Animal hygiene is important and all dairy farmers, suppliers to dairy farmers, milk carriers and hauliers, dairy product and food manufacturers, distributors and retailers should be part of an integrated food safety and quality assurance management system (Ngigi, 2003). Good farming practices underpin the marketing of safe, quality-assured milk based products. It was from this understanding that the researcher drew out the role of dairy farmers which is primarily to ensure that good agricultural, hygienic and animal husbandry practices are employed at the farm level.

This study therefore, sought to determine the influence of good dairy farming practices on milk production as it gave a better comprehensive understanding in order to suggest some commendable dairy farming practices.

1.3 Purpose of the Study

The purpose of this study was to determine the influence of dairy farming practices on milk production with reference to Githunguri Constituency, Kiambu County.

1.4 Objectives of the Study

The following were the objectives the study sought to achieve

(i) To determine the extent to which dairy animal nutrition influences the milk production in cattle in Githunguri Constituency, Kiambu County

(ii) To explore the extent to which animal health influences the level of milk production in Githunguri Constituency, Kiambu County

(iii) To determine the role played by animal hygiene in improving and sustaining milk production in Githunguri Constituency, Kiambu County

(iv) To assess the extent to which observance of animal welfare influences the performance of the cattle in terms of milk production in Githunguri Constituency, Kiambu County

(v) To establish the extent to which Socio-economic management influences milk production in Githunguri Constituency, Kiambu County

1.5 Research Hypotheses

The study sought answers to the following research questions:

H_1 There is no significant relationship between nutrition of dairy animals and milk production in Githunguri Constituency, Kiambu County

H_2 There is no significant relationship dairy animal health and the level of milk production in Githunguri Constituency, Kiambu County

H_3 There is no significant relationship between dairy animal hygiene and the level of milk production in Githunguri Constituency, Kiambu County

H_4 There is no significant relationship between the respect for dairy animal welfare and milk production in Githunguri Constituency, Kiambu County

H_5 There is no significant relationship between socio-economic management of dairy animals and milk production in Githunguri Constituency, Kiambu County

1.6 Significance of the Study

Results from this study will provide useful information to dairy farmers since a lot of emphasis has been laid on the aspect of growth and sustainability of the industry which should be managed effectively. This will assist farmers develop strong and dynamic dairy farming practices that will effectively offer them the desired results in a bid to help them reap great benefits from the industry. The same will improve community's approach to the right dairy farming practices.

Findings of this study will contribute to the information resource for use by various organizations and governments for the purpose of advancing dairy farming practices and making it a useful approach to community development. The study will also be invaluable to various policy makers in formulation of regulation governing the industry to increase milk production resulting in national food security through improvement in the quality of milk products, creating employment opportunities both in the rural and urban areas in line with the Millennium Development Goals and Economic Recovery Strategy. Similarly, researchers will find this useful in advancing their knowledge on the subject and offering a good link to further research as the sector continues being more dynamic.

Findings of this study will benefit other development partners interested in improving the dairy sector. Finance institutions will find this study useful in understanding the nature of industry of their clientele which is mainly the farmers' cooperatives. They will therefore be in a better position to address the challenges facing them and farming industry in general. The financial institutions will be able to delve into the dynamics that influence their good use of the financial services they extend to them. Ultimately, this will help in packaging their services effectively and facilitating successful financial advisory initiatives with the relevant farmers cooperatives.

1.7 Limitations of the Study

While conducting the survey, the researcher encountered some factors that hindered achievement of objectives. One of the factors was respondent bias whereby the respondents gave responses that were likely to favour the researcher's results. The researcher assured the respondents of confidentiality of information given and also assured them that the information was to be used for academic purposes only by having an introduction letter from the university. Also due to the nature of the industry, availability of some farmers was

complex since they were out in the fields looking for pastures or dealing with milk deliveries which meant that the researcher had to work on a tricky time frame. This was mitigated by visiting them either very early in the morning or late in the evening as they went about the milking and delivering of the milk to the dairy cooperatives.

1.8 Scope of the Study

The study was carried out in Githunguri Constituency, Kiambu County in the Central region of Kenya. The choice of the area of study was informed by the fact that the local cooperative society was one of the oldest and very successful in dairy production. This choice of study area provided the desired data for the study. It limited the scope of the study hence saved on both time for data collection and the finances that were used during the data collection.

1.9 Basic Assumptions of the Study

In carrying out this study, a number of assumptions were in place:

Respondents for the study were exposed to the same social economic, environmental and climatic factors. Selected respondents adequately represented the whole population and that they cooperated. There was adequate time to study all the respondents selected for the study.

1.10 Definition of Significant Terms as used in the Study

Animal hygiene This refers to cleanliness and to prevention of contamination. They are conditions and practices that serve to promote or preserve health of an animal.

Animal nutrition focuses on the dietary needs of domesticated animals, primarily those in agriculture and food production.

Animal welfare Refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment. Protecting an animal's welfare means providing for its physical and mental needs.

Dairy Animal health Refer to the art of ensuring that animals are in a good state free from diseases and infections.

Dairy farming practices	Refers to the implementation of effective and responsible management of human resources, ensuring farm tasks are carried out safely and competently and management of the enterprise to ensure its financial viability.
Dairy farming	Dairy farming is a class of agricultural, or an animal husbandry, enterprise, for long-term production of milk, usually from dairy cows but also from goats, sheep and camels, which may be processed on-site or transported to a dairy factory for processing and eventual retail sale.
Socio-economic management	These are changes to society or the economy that influences animal production.

1.11 Organization of the Study

Chapter one was presented the background information about the area being studied. This was followed by a statement of the problem and the purpose of the study which gave the focus of the whole study. Key objectives that needed to be achieved were listed and also the research questions that this study sought to answer. Other sections included delimitations which set the boundaries of the study, possible limitations to the study as well as definition of significant terms. On the other hand, chapter two reviewed the literature based on the objectives of the study. It further looked at the conceptual framework and finally the summary. Chapter three covered the research methodology of the study. The chapter describes the research design, target population, sampling procedure, tools and techniques of data collection, pre-testing, data analysis, ethical considerations and finally the operational definition of variables. Chapter four deals with data analysis and presentation of findings and chapter five summary of findings, discussions, conclusions, recommendations and suggestion for further studies.

CHAPTER TWO
LITERATURE REVIEW

2.1Introduction

This chapter presents information on ways in which factors such as nutrition, animal health, animal hygiene, animal welfare and socio-economic management influence dairy production. The chapter highlights the theory in which the study is based and explores varied references of literature sought that endeavours to objectively inform and provide a basis of answering the research questions outlined in chapter one. The chapter is also set to deal with adoption of knowledge and technology, and the role it plays in the complexity of issues that the farmer can decide to embrace or ignore based on personal believes, the level of sensitization and the education level. It as well establishes the conceptual framework showing how different variables herein relate with each other in guiding the study.

2.2Dairy Animal Nutrition Perspective

Proper feeding and good balanced rations remains the cornerstone of a successful dairy operation. Milk yield per cow and the cost of feed to produce milk have by far the greatest influence on profitability in a dairy operation. If a dairy is to be successful, the dairymen must continually strive to adopt practices that allow the greatest output of milk at the most economical cost. Successful dairying in the future will depend on high levels of milk production, culling for low production, controlling feed costs, and using good replacements (Staal and Pratt, 2001).

Cow identification and good records make good feeding practices possible. Without milk production records, it is difficult to feed according to milk production or to use any well-designed group feeding system. Milk yields per cow continue to increase annually as reported by the USDA National Agricultural Statistics Service. Average production per cow in the United States reported in 1975 was 10,360 lbs as compared to 56,213 lbs in 2001. Much of this increase in milk production is due to better nutrition and feeding, overall management practices and the genetic improvement of the cow population (Bayemi 2005).

Feeding standards have been used since the late 1800s to help guide nutritionists and livestock producers in formulating rations and feeding livestock. Periodically, the standards are updated to encompass the most current research information available. The standards that

are now available, entitled "Nutrient Requirements of Dairy Cattle," were updated in 1988 by a subcommittee on Dairy Cattle Nutrition of the National Research Council (Suttie, 2001).

As milk production increases, it becomes important that some dietary protein escape degradation in rumen fermentation. Protein that bypasses the rumen is degraded to amino acids and absorbed from the small intestine for utilization (De Leeuw, 1998).These essential amino acids are needed by the high producing cow and must come either from dietary protein that escapes degradation or microbial protein produced during rumen fermentation and passed along to the small intestine.

The 1988 Nutrient Requirements of Dairy Cattle discussed for the first time both absorbed and crude protein. The dietary intake protein is described as undegradable intake protein (UIP) and degradable intake protein (DIP). Although a specific percent UIP is not stated, the calculations suggest 35 to 40%bypass protein. Processing or heat treatment of feedstuffs increases the amount of bypass protein in the feed stuff. Commonly used bypass protein supplements are distillers' grains, brewers' grains, corn gluten meal, blood meal, meat and bone meal, feather meal and heat treated soybeans (Muriuki, 2012).

The most critical period in the cow's lactation is from parturition until peak production which takes from 5 to 8 weeks postpartum. It is during this period that the stage is set for obtaining the highest possible peak in production and also for the onset of normal reproductive cycling which may occur as early as 2 to 3 weeks in some cows. To be successful, the best strategies must be applied that include many areas such as feeding and management practices, quality and balance of feed, feed bunk management, milk practices, and the maintenance of good health (Diop, Mazouz, 1995).

2.3 Influence of Nutrition on Milk Production

Nutrition of the dairy cow affects the yield and proportion of milk components including protein, carbohydrates, vitamins and minerals. Proper feeding management of the dairy herd can improve the cattle production efficiency and provide for a healthier cow. Feeding to increase production of milk with maximum levels of milk fat and protein is essential for achieving these benefits. An animal's health and productivity, along with the quality and safety of her milk, depend on the quality and management of the feed and water. Milk quality can be affected adversely by the quality of feeds they ingest. If the water is contaminated, the

contaminants may cause milk safety and quality to suffer. Better understanding of the processes involved in animal nutrition could also contribute to improved management of some of the trade-offs that operate at high levels of animal performance, such as those associated with lower reproductive performance (Butler, 2000).

Proper nutrition is critical to enable modern, high-producing dairy cows to meet their genetic potential for milk production (Arimi et al, 2000). In fact, increases in milk production per cow over the past100 years can be attributed in large part to improvements in nutrition. Dairy farmers use professional animal nutritionists to develop scientifically formulated, balanced, and nutritious diets to support milk production, while optimizing nutrient management programs and minimizing pollution. Diets for cows include hay, grains, protein sources (e.g., soy) and vitamins and minerals. It is important to continually assess cows' nutrient intakes and their body condition as different weather conditions can influence their nutrient requirements (Muriuki, 2012).

While understanding of the science of animal nutrition continues to expand and develop, most of the world's dairy animals in many developing countries suffer from permanent or seasonal nutritional stress (Bruinsma, 2003). Poor nutrition is one of the major production constraints in smallholder systems, particularly in Africa. Research has been carried out to improve the quality and availability of feed resources, including work on sown forages, forage conservation, the use of multi-purpose trees, fibrous crop residues and strategic supplementation. There are also prospects for using novel feeds from various sources to provide alternative sources of protein and energy, such as plantation crops and various industrial (including ethanol) by-products. The potential of such feeds is largely unknown. Given the prevalence of mixed crop–livestock systems (where animals and crops are grown on the same farm) in many parts of the world, closer integration of crops and livestock in such systems can give rise to increased productivity and increased soil fertility (McIntire, 1992). In such systems, smallholders use crops for multiple purposes (food and feed, for example), and crop breeding programmes are now well established that are targeting stover quality as well as grain yield in crops such as maize, sorghum, millet and groundnut. Considerable work is however under way to address some of the issues associated with various anti-nutritional factors.

What are the prospects for the future? For the mixed crop–livestock smallholder systems in developing countries, there may be places where these will intensify using the inputs and tools of high-input systems in the developed world. In the places where intensification of this nature will not be possible, there are many ways in which nutritional constraints could be addressed, based on what is locally acceptable and available. One area of high priority for additional exploration, which could potentially have broad implications for tropical ruminant nutrition, is the effect of the rumen microbes on food (NRC, 2009).

While there is potential to improve dairy the world over, probably the most feasible solutions require integrated application of what is already known, rather than new technology. This could involve dissemination of information from early warning systems and drought prediction, for example, so that dairy farmers can better manage the complex interactions between animal size, feed availability and rainfall (NRC, 2009). These are the basis of GAP (Good Agricultural Practices) which is: Ensuring animal feed and water is of adequate quality, control storage conditions of feed and ensure the traceability of feedstuffs bought off farm.

Improved feed availability and quality will be a key strategy to realize the largest proportion of the needed animal productivity levels and supporting animal population increases. Feeding is the major constraint to achieving the targeted milk production because of heavy dependency on rain-fed forage and pasture production while there is poor adoption of conservation of animal feeds to smoothen seasonal fluctuations in milk production. Efficient utilization of dairy concentrates is needed to match the high cost of quality concentrates and weak enforcement of standards that has failed to discourage infiltration of substandard commercial feeds into the market. According to the Dairy Master plan (2010), the actions that can enhance better feeding for increased animal productivity include the following: increase acreage under pasture and fodder, increase availability of seeds of improved forage varieties, promote adoption of feed conservation technologies, enforce standards of both raw materials and finished concentrates and train more farmers to make home ration formulation and on mixing of feeds. These feeding strategies when adopted will enhance reproductive performance in the national herd.

Feeding of a dairy cow is very important as a high and economic milk production can only be achieved with well-fed cow. The cost of feeding contributes highest to total cost of milk

production. If a cow is kept under zero grazing, feeding needs even more attention as she will entirely depend on how the farmer feeds her. A dairy cow requires feed for the following purposes: milk production, body maintenance, her own growth and the growth of the calf (if pregnant). This implies that the cow should receive a ration balanced in energy, protein and minerals. Unbalanced ration leads to decreased milk production, poor body condition of the cow and fertility problems. Good feeding leads to higher milk production, good health, and more calves. However, good quality feeds are expensive. Feeding is the major constraint to achieving the targeted milk production because of heavy dependency on rain-fed forage and pasture production while there is poor adoption of conservation of animal feeds (Quisumbing, 2003).

Feeds can be divided into two groups, roughages and concentrates. Roughages are bulky feeds like napier grass, maize stover, Lucaena, banana stem, sweet potato vines, hay and silage. These feeds are usually grown on the farm and are the cheapest to feed to the cow. Good quality roughage is the basis of a high milk production. Roughages like maize stovers, banana stems, yellowish napier grass and silage of napier grass are low in protein. In order to compensate for this shortage, roughages rich in protein like Leucaena, desmodium, sweet potato vines, leaves of fodder trees should be added to balance the ration (Ministry of Livestock Development). These legumes should not be fed in large quantities because of poisoning and or bloat. Efficient utilisation of dairy concentrates is needed to match the high cost of quality concentrates The quality of commercial concentrates may be doubtful due to weak enforcement of standards that has failed to discourage infiltration of substandard commercial feeds into the market. Minerals (for example calcium, phosphorus, magnesium, copper, salt,) supplements are very important for a dairy cow. Lack of certain minerals can result in: poor fertility, low milk production, deformed skeleton in young animals and metabolic diseases like milk fever or hypocalcaemia (Bhattarai, 2009).

In addition to improving milk production, nutrition impacts animal health and well-being (Mwangi, 2007). Cows that are fed properly have fewer metabolic diseases and better immune function. Also, cows' diets can influence the environment and efficient use of the earth's natural resources. Because feeding excess nitrogen and phosphorus to cows contributes to air and water pollution, modifications in cows' diets are made to find the right balance of nutrients to increase milk production while minimizing environmental pollution.

With respect to using the earth's resources efficiently, proper nutrition leads to higher milk production which is associated with a greater proportion of feed nutrients being converted to milk (Gatonye and Esipisu, 2007). Advances in nutrition have been and will continue to improve the productivity of dairy cows, as well as the dairy industry's role as stewards of the environment.

Feeds used in Kenya have been reported to be of low quality and in some cases contaminated with aflatoxins which have been found in milk. A study by the university of Nairobi on the prevalence of contaminants in dairy feeds in Nairobi peri urban (Mwangi, 2007) concluded that 50% of commonly used feeds - maize germ, cotton seed meal, wheat bran were contaminated with aflatoxins and pose serious implications on livestock and human health.

2.4Animal Health Influence on Milk Production

A number of hygiene scoring systems for dairy cows have been developed to record the degree of contamination of different anatomical areas with dirt and faecal matter, thus giving an overall assessment of the cleanliness of the whole animal (Hughes, 2001; De Rosa., 2003). Hygiene scoring of cattle is routinely used in the beef industry in the UK to assess the cleanliness of cattle prior to slaughter as part of the Clean Livestock Policy to reduce the potential risk of contamination of carcasses with dirt and faecal material (Meat Hygiene Service, 1987). In the dairy industry it has been used as a possible indicator of cow welfare and in studies of the influence of housing conditions on mastitis incidence (Ward, 2002), the effects of tail docking (Schreiner and Ruegg, 2002), sub-clinical intra-mammary infection rates (Schreiner and Ruegg, 2003) and the risk of bacterial contamination of milk (Sanaa, 1993). Animal-based health and welfare assessment is used as a tool to determine the effects of different management systems on the cows themselves, as opposed to evaluating the provision of resources on a farm (Main, 2003; Whay, 2003). There is increasing interest in, and demand for, animal-based assessment of livestock from organic and conventionally managed farms, allowing benchmarking between farms and to compare the effects of different management systems (Pye-Smith, 2003; Huxley, 2004).

Animals should be observed regularly and proven methods used to aid in detection and accurate diagnosis of infectious diseases. The diseases should be treated by proven methods after accurate diagnosis to minimize the prevalence of infection. Also, sick animal should be isolated from the other cattle on the premises to minimize the spread of diseases. Appropriate

procedures to separate milk from sick animals and animals under treatment should be followed to prevent further contamination. It is important that other people handling dairy cattlefor example veterinarians know what treatments have been given to the cows. An appropriate system should be put in place to readily identify treated animals (for example paint udders treated for mastitis) (Bebe et al, 2003).

Residues of any chemical administered have the potential to damage milk markets. Farmers should manage the use of all chemicals to prevent unacceptable chemical residues occurring in milk as unsuitable chemicals adversely affect animal health and productivity. Farmers need to be aware of all chemicals that may leave residues in milk. These may include detergents, disinfectants, anti-parasitics, antibiotics, herbicides, pesticides and fungicides. Farmers should use chemicals only for the purpose for which they are approved - lactating cows should never be treated with veterinary products that are not recommended for treatment of cows producing milk supplied for processing or otherwise used for human consumption; read the label - it should contain all the information about legal and safe use of the chemical; follow the advice given on the label and any chemical data sheet or risk assessment; observe withholding periods (the minimum times when milk should not be sold for human consumption after application of chemicals). It is important to note that veterinary medicines are chemical and biological products sold for the treatment of animals where evidence of proven efficacy and safety have been examined by independent review bodies to ensure that the products are suitable for their purpose(Bhattarai, 2009). These medicines may require a prescription from a veterinarian to allow purchase and to confirm that their use is appropriate.

Proper animal care and environmental practices, as well as dairy food safety and quality, are priorities for all dairy farmers. Conventional dairy farmers, with the help of animal scientists and veterinarians, strive to provide dairy cows with comfortable living conditions, nutritious diets, and good medical care (Mumba, 2011).Dairy farmers depend on healthy cows for their livelihood. Adopting appropriate farm management practices such as milking hygiene, environmental sanitation, and regular veterinary care (e.g., periodic check-ups, prompt treatment of illness) of cows helps to assure the well-being of dairy cows and reduce their risk of infections such as clinical mastitis (Omore et al, 2005). During the past 25 years there has been a major shift from treatment to prevention of disease in cows and, as a result of new technologies, subclinical conditions can now be identified. Veterinarians have contributed to

the development of on-farm data management systems and computer software that allow for early detection of health problems and the tailoring of disease prevention and treatment to individual herd needs (Bebe et al, 2002).

Conventional dairy farmers give antimicrobial drugs (i.e., antibiotics) to cows for a short period of time to treat certain conditions such as clinical mastitis (Mbugua et al, 2006). Dairy farmers keep meticulous records of these treatments. Concern related to the presence of antibiotics in conventionally produced milk available for consumers is unfounded. When antibiotics are given to a cow, her milk is diverted from the rest of the milk produced on the dairy farm until it tests free of antibiotics. Every tanker load of milk, whether it is from a conventional farm or an organic farm, is strictly tested for antibiotics (Tegemeo, 2006).

In the extremely rare event that any milk tests positive of the antibiotics, the milk is disposed of immediately, never reaching the public. Further, dairy farmers are financially liable if antibiotics are found in the milk. As a result of stringent government regulations, neither conventionally produced milk nor organically produced milk contains illegal antibiotic residues (Ngigi, 2005).

To assure healthy air quality and avoid heat stress in dairy cows, most modern dairy farms use shades and advanced ventilation systems. On warm days, farmers use fans, foggers, misters, or sprinklers to effectively cool cows and improve milk production and reproductive efficiency (Karanja, 2003). The health and performance effects of heat stress on dairy cows have been quantified.

2.5Animal hygiene Influence on milk production

Despite its broader etymological sense, the word hygiene is related in many countries to cleanliness and to prevention of contamination. An agreement is generally found on the importance of hygiene in livestock production (Thomas, 1982, Radostits, 1994).Milking being the most important single activity on the dairy farm means that consumers demand high standards of milk quality, so milking management aims to minimize microbial, chemical and physical contamination. Milking management covers all aspects of the process of obtaining milk from cows quickly and effectively, while assuring the health of the cows and the quality of the milk. This is attained through ensuring milking routines do not injure cows or

introduce contaminants in milk; ensuring milking is carried out under hygienic conditions; ensuring milk is handled properly after milking (Mbugua et al, 2006).

Quality of milk plays a very important role in ensuring that markets are accessible and that milk is able to be retained at retail level. This is because milk can be a carrier of life-threatening diseases. The processor therefore puts measures in place to ensure that it is not compromised and farmers comply with the regulations on health standards throughout the dairy supply chain (Land O'Lakes, 2007: 2)

The quality should be acceptable for use both for the processor and producer regardless of whether the farmer is commercial or smallholder. This is important because when dealing with issues of food safety, hygiene becomes paramount. Since the farmers produce is based on composition and hygiene, the higher the butter fat, the more profitable the raw milk is. Nonetheless, proper milk hygiene is vital as it could be detrimental for those farmers for whom milk income significantly contributes to livelihoods (Mosnier and Wiek, 2010). Although milk processing reduces the bacterial load, maintaining good quality at the producer level is cardinal.

In their quest to meet standard quality, some dairy farmers use a well-kept cloth to clean and vaseline to lubricate the udder before milking. This is their way of re-inventing and re-constructing the technology to suit their circumstances. Due to the fact that composition and food safety are the key aspects in the criteria for accepting milk, it is vital that all producers comply with the quality and safety procedures throughout the process from production and collection to processing and distribution (Land O'Lakes, 2007)

It is important to ensure good milking techniques. Incorrect techniques can result in a higher mastitis risk and injury to the cow. The correct technique is to prepare cows well before milking; avoid unnecessary air entering while attaching the cups to the milking glands when using machine milking, if applicable; minimize over milking; remove cups gently, if applicable. Cows whose milk is unfit for human consumption should be milked last or with a separate bucket or system. Discard abnormal milk in a manner appropriate to the risk posed (Mosnier and Wiek, 2010).

A sufficient supply of clean water should be available for milking operations and for cleaning equipment that comes into contact with milk. A high standard of cleanliness should be maintained at all times in the housing area. The housing area should be designed to provide good drainage and ventilation and to avoid animal injury as well as suitable in size and designed to match the size of the animal. The milking area should be designed to allow it to be kept clean and tidy (Muriuki, 2010).

Management of manure is a complex environmental issue on farms of all sizes as manure can have both positive and negative environmental consequences (Kimani and Harris, 2001). Dairy farmers on both conventional and organic farms effectively recycle manure nutrients as a fertilizer to replenish soils so crops grow better, while avoiding pollution. Manure supplies plant nutrients, improves soil structure, aeration, and water-holding capacity of the soil, and promotes the growth of beneficial organisms in the soil. Engineers and other experts help dairy farmers design manure handling systems, from how animals are fed and housed, to manure handling and storage, transportation, land application of manure, land management, and record keeping (Mwangi, 2004).

Recent studies in Central Kenya and especially Kiambu County show increasing incidences of mastitis (Director of Veterinary service annual report, 2006) and the Kenya Dairy Board attributes the high level of bacteria load in milk due to poor hygiene at farm level (Muchirii, 2007; Mwangi, 2007). Hygienic milk production at farm level is the starting point in quality assurance of milk in the dairy chain. Omore et al (2005) in his study on addressing public health and quality concerns of marketed milk in Kenya showed that there were unacceptable levels of quality of milk and recommended training of dairy farmers in specific farm practices.

2.6Animal Welfare Influence on Milk Production

In essence, animal welfare is the application of sensible and sensitive animal husbandry practices to the livestock on the farm. Animal welfare is primarily concerned with the well-being of the animal. According to Broom and Johnson (1993), "Welfare is a characteristic of an animal, not something given to it". This would mean, that animal welfare refers only to human beings' effects on animals, thus, the concept may be irrelevant to wild animals. Referring to his students' opinion (Appleby, 1996) the may be defined as "The state of well-being brought about by meeting the physical, environmental, nutritional, behavioral and

social needs of the animal or groups of animals under the supervision or influence of people." In America the use of the term "welfare" means something provided for humans in need. In Fraser's (1989) view "well-being" refers to endogenous states of being within an animal and "welfare" to human interventions designed to promote well-being. In *Hughes's* word (1976) welfare is "a state of complete mental and physical health, where the animal is in harmony with its environment", but it may be a subject of change. "Welfare can vary between very poor and very good. In order to use the concept of welfare in a scientific way it is necessary to specify the level of an animal's welfare and not simply to reserve the word to indicate that the animal has, or does not have, problems" (Broom and Johnson,1993). Animal welfare refers to freedom from hunger and thirst, malnutrition, discomfort, pain/ injury/disease and freedom to express normal behavior, fear/stress. In developing countries, scarce resources are directed towards human rather than animal problems, resulting in poor welfare.

To measure wellbeing we speak about assessment, to ameliorate suffering about solutions and about how to solve them in practice about implementation (Appleby and Hughes, 1999). The welfare of an animal is determined by the quality and quantity of its experiences. The quality of an experience relates to how good or bad it is and its duration, and the quantity relates to the frequency of each type of experience (Phillips,2004). The interpretation of what level of animal welfare is desirable in different systems of animal production will be varied according to the interest group: consumers, non-consumers, producers, vets, advisers or inspectors. The level of animal welfare on production units is mainly dictated by the quality of animal management, which also will have an important influence on the profitability of the unit. Farm animals have 'needs' that relate both to life preservation and reproduction. In relation to the former, an adequate supply of food and water and a good health status are most likely to be limiting for dairy cows. In relation to the latter, the total environment must be entirely suitable for it to be worthwhile for the animal to expend resources on reproduction. Thus factors such as temperature stress, social stress etc may limit reproduction but are not life threatening. Obviously, farm animals also have 'desires', in relation to quality of life, such as companionship, space, and possibly variety in the diet. Animal welfare standards have been incorporated into most on-farm food quality and food safety schemes. Animal welfare codes usually list five basic freedoms that should underpin best farm practice in relation to animal welfare. These five freedoms provide a comprehensive overall concept of animal welfare. These should ensure animals are free from thirst, hunger and malnutrition,

animals are free from discomfort, animals are free from pain, injury and disease, animals are free from fear and that animals can engage in relatively normal patterns of animal behaviour

A competent operator should be able to recognize whether or not the animals are in good health, understand the significance of a change in the behavior of the animals, know when veterinary treatment is required, implement a planned herd health management programme (for example preventive treatments or vaccination programmes if necessary), implement appropriate animal feeding and grassland management programmes, recognize if the general environment (indoors or outdoors) is adequate to promote good health and welfare, have management skills appropriate to the scale and technical requirements of the production system, and handle animals compassionately and in an appropriate manner, anticipate potential problems and take the necessary preventive action (Muchirii, 2007).

Recognizing that proper animal care leads to the production of high quality milk, dairy farmers routinely employ many animal care practices such as providing cows with comfortable living conditions, nutritious diets, and good medical care. Dairy farmers, with the help of animal scientists and veterinarians, are continually making improvements related to housing, stall surfaces, bedding, ventilation and cooling, and formulation and delivery of feed rations, which enhance the welfare and reproductive and lactation performance of cows. On most modern conventional dairy farms, cows are allowed access to pasture and direct sunlight as well as provided with housing. It is important to appreciate that dairy cows are very adaptable, and as long as they are given a healthy environment, they will grow and produce high quality milk. Many of today's modern dairy farms use "free-stall" housing, which is an open, curtain sided barn designed to maximize cow comfort, and that allows cows to eat and sleep whenever and wherever they choose, and move on their own from their pens and fields to and from the milking parlor (Muriuki, Wanjohi and Njuguna, 2010). Dairy farmers select stall surface and flooring material in barns to improve cow comfort, which in turn increases milk production. For example, the selection of rubber and other non-slip surface material for stall floors makes it easier for cows to move around. In particular, comfortable bedding in free-stalls increases the length of time cows spend lying down, which increases their milk production (Delgado, 2005). Waterbeds, sand beds, sawdust bedding, or mattresses made of rubber, foam, or a combination of the two improve cow comfort (Straub, 2009).

Many dairy farmers implement best management practices to provide comfortable, safe, and hygienic conditions for both mother and calf during the birthing process and afterwards (Muriuki, 2010). This means providing clean, dry bedding, strategic vaccination protocols, hourly monitoring of maternity pens, prompt feeding of colostrum (the mother's first milk after giving birth) to newborn calves, and removal of calves from housing for adult animals to calf hutches to minimize calf injury.

2.7 Socio-Economic Management Influence On Milk Production

Being 'socially responsible' and 'economically sustainable' are integral to good dairy farming practice as they address two key risks to the farm enterprise. Keeping dairy animals is an important risk reduction strategy for vulnerable communities, and livestock are important providers of nutrients and traction for growing crops in smallholder systems. Dairy products contribute 17 per cent to kilocalorie consumption and 33 per cent to protein consumption globally, but there are large differences between rich and poor countries (Rosegrant, 2009).

Dairy systems have both positive and negative effects on the natural resource base, public health, social equity and economic growth (World Bank, 2009). Currently, livestock and by extension dairy farming is one of the fastest growing agricultural subsectors in developing countries. Its share of agricultural GDP is already 33 per cent and is quickly increasing. This growth is driven by the rapidly increasing demand for dairy products, this demand being driven by population growth, urbanization and increasing incomes in developing countries (Delgado, 2005).

The suggested good dairy farming practices for the socio-economic management of dairy farms are implementing effective and responsible management of human resources, ensuring farm tasks are carried out safely and competently and management of the enterprise to ensure its financial viability (Muriuki, Wanjohi and Njuguna, 2010).

2.8Theoretical Framework

This section looks at the theory or model that the study applied. The study was hinged on the innovation-diffusion model.

2.8.1 Innovation –Diffusion Model

The innovation-adoption model was developed by Rogers (2003), who postulated a number of stages through which a targeted buyer or customer passes, from a state of unawareness, through awareness, interest, trial, to purchase/adoption. The decision process to `adopt a particular technology involves farmers acquiring information because they face yield uncertainties and varying risk preferences. This implies that there is a relationship between production uncertainty and technology adoption as farmers will attempt to protect themselves against input related production risks. An individual therefore has to make choices from the pool of alternatives that are at their disposal. In the context of dairy technologies, smallholder farmers are provided with these technologies by the government, organizations providing interventions through various projects or even milk processors such as Githunguri Dairy Farmers Co-operative Society in this case. It is assumed that they will make decisions of adopting or rejecting the technology based on socio-economic factors such as herd size, farm size, labour availability, credit constraints and risk and uncertainty, among others. Focus should therefore be on the adopter as they determine how much of the technology will be adopted.

According to Rogers (2003), the decision to adopt is a process that does not happen spontaneously, but happens over time. A farmer will try out different technologies to see what works well on their farm with the available resources before making the decision to incorporate a particular technology into practice. The model presents some stages that an individual should go through before a technology is adopted. In the first instance, farmers learn about various technologies that are available through information dissemination workshops and other training programmes. The farmers hear about these technologies from their neighbors, the cooperative society to which they belong and extension officers. Some farmers are interested in having the latest information at their fingertips and therefore carry out research and read widely on the latest technologies and are able to apply them to their practice. In the second stage, farmers are persuaded to know more about the technology after hearing about it. Their attitudes therefore change and are interested in knowing more about

the technology, how it works and what it can do for them. This is a vital stage because it plays a major role in influencing their decision to adopt or reject the technology. The farmers then decide to try out the technology. The knowledge gained forms a basis for adoption or rejection depending on how well the technology is understood and their perception of benefits.

At implementation, the farmer incorporates the technology in their practice while adapting it to suit their circumstances. This aspect of re-inventing makes the technology flexible and could be beneficial to adopters (Rogers, 2003). However, farmers can also decide to discontinue with the technology if they feel it doesn't provide the expected benefits. The last stage involves confirmation of the farmer's decision –positive or negative. Farmers make their decisions based on expected impacts on the wellbeing of their households particularly on household income. If there are prospects for higher profitability, greater consumption and higher nutritional outcomes, chances of adoption could possibly be higher (Quisumbing, 2003).

2.9 Conceptual Framework

Independent variable

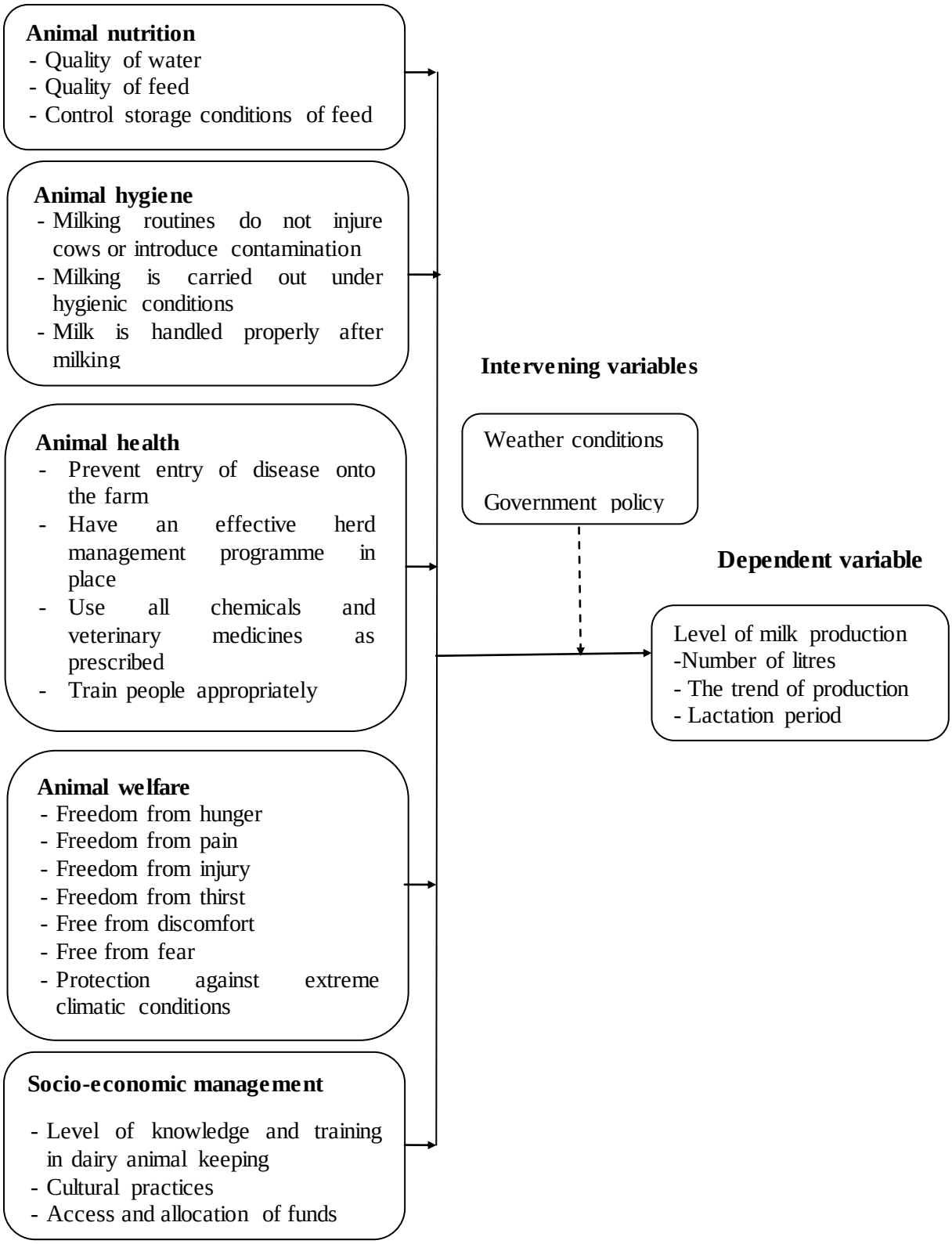

Figure 1: Conceptual framework

2.10 Knowledge Gap

Table 2.1: Knowledge Gap

Author	Title	Finding	Knowledge Gap
Bayemi et al	Appraisal of Dairy Farms in the North West Province of Cameroon. Livestock Research for Rural Development	The aim of crossbreeding is to upgrade for better milk production and at the same time retaining the adaptability of the animals in changing environmental conditions	• The study was conducted in Cameroon not in Kenya • The study looked at dairy farms not dairy farming practices
Doss	Understanding Farm-level Technology Adoption: Lessons Learned from CIMMYT's Micro Surveys in Eastern Africa,	As long as there is someone more educated in the household, production will be enhanced	• The study was done in Mexico • The study did not look at dairy farming practices
Kimani and Harris	Manure Management in the Kenya Highlands: Practices and Potential	Management of manure is a complex environmental issue on farms of all sizes as manure can have both positive and negative environmental consequences	• The study was not conducted in Githunguri • The study looked at manure management and not dairy farming practices
Muriuki, Wanjohi and Njuguna	Improving Livelihoods in the	Many of today's modern dairy farms use "free-	• The study did

	Smallholder: Dairy Sector in Kenya Evaluation	stall" housing designed to maximize cow comfort, and that allows cows to eat and sleep whenever and wherever they choose, and move on their own from their pens and fields to and from the milking parlor	not focus on Githunguri • The study did not focus on dairy farming practices

2.11Summary of the Chapter

The study focuses on the relationship between consumer safety and economic, social and environmental management at the farm level. Dairy farmers' production systems worldwide need to be able to combine profitability with the responsibility of protecting human health, animal health, animal welfare and the environment. This study gives individual dairy farmers proactive guidance on how these objectives can be achieved on their farms. The practices that are suggested have been drawn from best practice guidelines and existing assurance schemes around the world, and so individual practices will vary in their applicability to various dairying regions. The underlying factor however is the level of knowledge and technological advancement by individual farmers as well as the ability and proactivity of the agricultural officers to disseminate the same. This is important since some farmers may ignore practices as they may deem them not relevant to them and hence achieving results at a below optimal level. Most of the literature reviewed in this chapter is from developed countries whose strategic approach and financial footing is different from that of Kenya. There is therefore a gap on the influence of dairy farming practices on milk production in Kenya. This study seeks to fill this gap by establishing how animal nutrition, animal hygiene, animal health, animal welfare and socio-economic management influence milk production in Githunguri Constituency, Kiambu County.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a detailed description of the methods that was employed in carrying out this research. This research was organised under the following subsections: the research design that gave a complete guide to the researcher in collecting, organizing, and interpreting observed facts or data, details of the target population and sampling procedures for coming up with specific population of study, methods of data collection, validity, and reliability, methods of data analysis and interpretation, ethical issues and operationalization of variables.

3.2 Research Design

The research design that was adopted in this research was descriptive design. The major purpose of descriptive study was description of state, as it exists. It is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals (Orodho 2003). According to Mugenda (1999), descriptive study is a process of collecting data in order to test hypothesis or to answer questions concerning the status of the subject in the study. Kothari (2003) on the other hand recommends descriptive study as it allows the researcher to describe, record, analyse and report conditions that exists or existed. The study was aimed at collecting information from respondents on the influence of good dairy farming practices to milk production.

3.3 Target Population

A population is referred to as the entire set of relevant units of analysis, or data. Target population thus is referred to as the aggregate of all cases that conform to some designated set of specifications (Isidor Chein, 1982). According to Kisilu and Tromp (2006), a population is a group of individuals, objects or items from which samples are taken for measurement, it is an entire group of persons or elements that have at least one thing in common. Mugenda and Mugenda (2003) say that target population refers to the population to which a researcher wants to study. The target population of this study included dairy farmers, milk processing plants and dairy officers. Githunguri Constituency consisted of 10,136 dairy farmers (Githunguri Constituency Livestock Census Records, 2012).

Table 3.1: Target population

Wards	Frequency	Percentage
Githunguri	2642	26.1
Githiga	1734	17.1
Ikinu	2183	21.5
Ngewa	1843	18.2
Komothai	1734	17.1
Total	**10136**	**100.0**

Source: Githunguri Constituency Livestock Census Records (2012).

3.4 Sampling Design and Sample Size

Sampling is the procedure a researcher uses to gather people, places, or things to study. It is a process of selecting a number of individuals or objects from a population such that the selected group contains elements representative of the characteristic found in the entire group (Orodho and Kombo, 2002). According to Singleton (1998), sampling is that part of the research that indicates how cases are selected for observation. Stratified proportionate random sampling technique was used to select the sample. According to Deming (1990), stratified proportionate random sampling technique produce estimates of overall population parameters with greater precision and ensures a more representative sample is derived from a relatively homogeneous population. Stratification aims to reduce standard error by providing some control over variance. The study grouped the population into strata comprising of the various locations. From each stratum the study used simple random sampling to select 384 respondents. The respondents were systematically picked from the list of farmers collected from the Githunguri Constituency Livestock Census Records (2012). According to Cooper and Schindler (2003), random sampling frequently minimizes the sampling error in the population. This in turn increases the precision of any estimation methods used. The size of each stratum was determined using the Mugenda and Mugenda (2003) formula who indicated that when the population is more than 10,000, the population proportion can be estimated to be:

$$n = \frac{Z^2PQ}{\alpha^2}$$

Where:

Z is the Z – value = 1.96

P Population proportion 0.50

Q = 1-P

α = level of significance = 5%

$$n = \frac{1.96 \times 1.96 \times 0.5 \times 0.5}{0.05 \times 0.05}$$

$$n = 384$$

Table 3.2: Sampling Frame

Wards	Frequency	Ratio	Sample size
Githunguri	2642	0.038	100
Githiga	1734	0.038	66
Ikinu	2183	0.038	83
Ngewa	1843	0.038	70
Komothai	1734	0.038	66
Total	**10136**		**384**

Source: Researcher, (2013).

3.5 Research Instruments

This study used both primary and secondary data collected for the purposes of this study. For primary data, a questionnaire with closed and open ended questions was used to obtain the data from the respondents. The questionnaire provided enough spaces to record additional responses to the research question by the respondents. To gather data, the researcher used pre-designed questionnaires to capture information useful in meeting the stated objectives as well as answering the research questions.Secondary data was manually extracted from the Githunguri Constituency livestock census records.

3.6 Validity of the Research Instruments

Mugenda and Mugenda (1999) define validity as the accuracy and meaningfulness of inferences, which are based on the research results. To check validity, expertise from the supervisor were taken into consideration to ensure that the instruments were constructed correctly, have the right content, and if the instruments accurately represented the variables under study in line with the stated purpose and study objectives. The pre-test helped to improve face validity and content of the instruments. The internal validity which involved controlling the extraneous variables in the structure was done through the administration of the questionnaire. As such, the researcher sought assistance from the supervisor in order to help improve content validity of the instrument.

3.7 Reliability of the Research Instruments

According to Mugenda and Mugenda (1999), reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. To enhance the reliability of the instrument, a pre-test was conducted. The aim of pre-testing was to gauge the clarity and relevance of the instrument items so that those items found to be inadequate for measuring variables were either discarded or modified to improve the quality of the research instruments. This was to ensure that the instrument captured all the required data. The procedure for extracting an estimate of reliability was obtained from the administration of split half reliability method. The method involves splitting each instrument into two halves (odd and even items) then calculating the Pearson's correlation coefficient(r) between the responses (scores) of the two halves. The scores for all odd and even numbered items for each of the 20 respondents in the pilot study was computed separately. The correlation obtained represented the reliability coefficient of only half of the instrument. Hence a correction was made to obtain reliability of the entire instrument. Coefficient of 0.7 is a commonly accepted rule of thumb that indicates acceptable reliability (Mugenda, 2008). A composite Cronbach Alpha of 0.814 was established for all the questions indicating that the questionnaire was reliable as its reliability values exceeded the prescribed threshold (0.7) of acceptable reliability (Mugenda, 2008).

3.8Data Collection Procedures

To carry out the actual study, research assistants were recruited and trained in using the questionnaires for data collection. Homesteads were visited and the proprietor of the dairy enterprise engaged in answering the questionnaire. Every respondent were allocated enough time to complete the questionnaire on their own and the tool collected on completion.

3.9Data Analysis Methods

Data obtained from the field was coded, and analysed using a statistical package for social sciences (SPSS V. 21) to generate required information. Qualitative data from the open ended questions were analyzed thematically by content analysis and the findings presented in prose. In order to effectively analyse the primary quantitative data, descriptive statistics including percentages, frequencies, means and standard deviation were used. Presentation of

quantitative data was done using frequency tables. Regression analysis was conducted to show the strength of the relationship between the dependent and independent variables.

The regression model was:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$

Where:

Y = Level of milk production

β_0 = Constant Term

$\beta_1, \beta_2, \beta_3, \beta_4,$ and β_5 = Beta coefficients

X_1= Animal nutrition

X_2= Animal hygiene

X_3= Animal health

X_4= Animal welfare

X_5= Socio-economic management

ε = Error term

3.10 Ethical issues

Due to sensitivity of some information collected, the researcher held a moral obligation to treat the information with utmost propriety. Since the respondents were reluctant to disclose some information, the researcher reassured the respondents of use and confidentiality of the information given. All the respondents participating in the research were required to consent to take part in the study after they were made fully aware of the nature, purpose and their role in the study through the letter from the university and during planning meetings by the researcher herself.

3.11 Operationalization of variables

The following is the variables operationalization.

Table 3. 3: Operationalization of Variables

Research Objectives	Variables	Indicator	Measuring of Indicators	Data Collection Methods	Level of Scale	Types of Analysis	Type of Analysis
To determine the extent to which dairy animal nutrition influences the overall milk production in cattle	**Independent** Animal nutrition	- Animal feed and water - Storage conditions of feed - Traceability of feeds bought off farm	- Animals fed on good quality feed - Water and feeds preserved from contamination - Quality assurance of feed	Questionnaires	Nominal Nominal Ordinal	Parametric	Descriptive Regression
To explore the extent to which animal health influences the level of milk production in cattle	Animal health	- Entry of disease - Herd management - Use of veterinary medicines as prescribed - Train people	- Detect diseases early - Spread of disease - Transmission of zoonosis - Traceability - Follow correct procedures	Questionnaires	Ordinal Ordinal Nominal Ordinal	Parametric	Descriptive Regression
To determine the role played by animal hygiene in improving and sustaining milk production	Animal hygiene	- Milking routines do not injure cows or introduce contamination - Milking under hygienic conditions - Milk handling	- Suitable equipment for milking and storage - Milk is harvestinghygiene - High cleanliness standards	Questionnaires	Nominal Ordinal Nominal Ordinal	Parametric	Descriptive Regression
To assess the extent to which the observance of animal welfare influences the performance of the cattle in terms of milk production	Animal welfare	- Animals free from hunger, discomfort, pain, fear and free to engage in patterns of normal behavior	- Hunger and thirst - Pain and injury - discomfort - sanitary conditions - Safe environment	Questionnaires	Nominal Nominal Nominal Ordinal Ordinal Ordinal	Parametric	Descriptive Regression
To establish the extent to which socio-economic management influences milk production	Socio-economic management	- Education - Socially responsible - Economically responsible	- Level of training - Cultural practices - Funds availability	Questionnaires	Ordinal Ordinal	Parametric	Descriptive Regression
	Dependent Level of milk production	Volume of milk produced	- Number of liters produced per day	Questionnaires	Interval	Parametric	Descriptive Regression

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND PRESENTATION OF FINDINGS

4.0 Introduction

This chapter discusses the interpretation and presentation of the findings. This chapter presents analysis of the data on the influence of dairy farming practices on milk production; a case of Githunguri constituency, Kiambu County. The chapter also provides the major findings and results of the study.

4.1 Questionnaire Response Rate

The study targeted 384 respondents out of which 250 questionnaires were filled and returned giving a response rate of 65.1%.This response rate was good and representative and conforms to Mugenda and Mugenda (1999) stipulation that a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent.

Table 4. 1: Response Rate

	Frequency	**Percentage**
Returned	250	65.1
Not returned	134	34.9
Total	**384**	**100.0**

4.2 Demographic Information

4.2.1 Distribution of Respondents by Gender

The study sought to find out the gender composition of the respondents. The findings are presented in table 4.2.

Table 4. 2: Gender Composition

	Frequency	Percent
male	165	66.0
female	85	34.0
Total	**250**	**100.0**

From the findings, it was evident that majority of the respondents were male as shown by 66.0%. 34% of the respondents were female.

4.2.2 Distribution of the Length of Time Practiced In Dairy Farming

The study also sought to determine the length of time the respondents have practiced dairy farming. The findings are presented in table 4.3.

Table 4. 3: Length of Time Practiced In Dairy Farming

	Frequency	Percent
1 to 5 years	121	48.4
6 to 10 years	54	21.6
11 to 15 years	36	14.4
16 years and above	39	15.6
Total	**250**	**100.0**

From the findings, the majority of the respondents indicated that they had practiced dairy farming for a period of 1 to 5 years as shown by 48.4%. 21.6% of the respondents had practiced dairy farming for a period of 6 to 10 years.15.6% of the respondents indicated that they practiced dairy farming for a period of 16 years and above followed closely by 14.4% of the respondents who pointed out that they had practiced dairy farming for a period of 11 to 15 years.

4.2.3 Distribution of the Level of Education

The study sought to determine the level of education of the household heads as shown in Table 4.4.

Table 4. 4: Level of Education

	Frequency	Percent
Primary	46	18.4
Secondary	129	51.6
Tertiary	75	30.0
Total	**250**	**100.0**

According to the findings, majority of the respondents revealed that they have secondary level education as expressed by 51.6%. 30% of the respondents had tertiary level education and the rest (18.4%) had primary level education. The respondents also revealed that the farm size each respondent had was an average of 2 acres and that an average of 19 cattle were owned by the respondents in the farm. It was also evident that the amount of milk produced by a farm per day was an average of 35 kg.

4.3 Animal Nutrition

The study sought to examine the extent to which the respondents thought about nutrition of dairy animals as an influencing factor on milk production.

Table 4. 5: Extent to Which Nutrition of Dairy Animals Influence Milk Production

	Frequency	Percent
Very low extent	10	4.0
Moderate extent	18	7.2
Great extent	82	32.8
Very great extent	140	56.0
Total	**250**	**100.0**

According to the findings, majority of the respondents indicated that nutrition of dairy animals to a very great extent influenced milk production as shown by 56.0%. They also expressed that nutrition of dairy animals to a great extent influenced milk production as shown by 32.8%. 7.2%

of the respondents show that nutrition of dairy animals to a moderate extent influenced milk production.4.0% of the respondents also suggested that nutrition of dairy animals to a very low extent influenced milk production.

The study also sought to determine the level of agreement on various statements. The findings are as shown in Table 4.6.

Table 4. 6: Level of Agreement with Various Statements of Animal Nutrition

	Mean	Std. Deviation
Animals are fed on good quality feed	4.8160	.38826
Water supplies and feeds are preserved from chemical contamination	4.7840	.41234
There are good storage conditions of feed in the farm to avoid contamination	4.5880	.69584
There is quality assurance of feed supplier	4.5160	.79768
There is no chemical or toxin or use of prohibited ingredients	4.4920	.50094

From the findings, the respondents strongly agreed that animals are fed on good quality feed, water supplies and feeds are preserved from chemical contamination and there is quality assurance of feed supplier as expressed by a mean score of 4.8160, 4.7840 and 4.5160 respectively. They also strongly agreed that there are good storage conditions of feed in the farm to avoid contamination as expressed by mean score of 4.5880.The respondents agreed that there is no chemical or toxin or use of prohibited ingredients as expressed by 4.4920.

4.4 Animal Health

The study sought to determine the extent that dairy animal health influences the level of milk production. Findings are presented in table 4.7.

Table 4. 7: Extent That Dairy Animal Health Influences the Level of Milk Production

	Frequency	Percent
Very low extent	9	3.6
Moderate extent	27	10.8
Great extent	103	41.2
Very great extent	111	44.4
Total	250	100.0

According to the findings, majority of the respondents indicated that dairy animal health influenced the level of milk production to a very great extent as shown by 44.4% followed closely by 41.2% of the respondents who indicated that dairy animal health influenced the level of milk production to a great extent. 10.8% also indicated that to a moderate extent, dairy animal health influenced the level of milk production with only 3.6% of the respondents who indicated that dairy animal health influenced the level of milk production to a very low extent.

The study also sought to find out the level of agreement based on various statements as shown in table 4.8.

Table 4. 8: Level of Agreement Based On Various Statements Regarding Animal Health.

	Mean	**Std. Deviation**
I usually detect animal diseases early	4.7840	.41234
We normally prevent spread of disease among animals	4.5160	.79768
There are mechanisms to prevent transmission of zoonosis	4.5680	.99280
I follow correct treatment procedures whenever the animal is sick	4.7440	.57949
There are mechanisms to ensure traceability	4.1960	.55027
We always prevent occurrence of chemical residues in milk	4.4080	.83686

From the findings, majority of the respondents indicated that they strongly agreed that various statements contributed significantly to animal health such as 'I usually detect animal diseases early', 'we normally prevent spread of disease among animals' and that there are mechanisms to prevent transmission of zoonosis as expressed by a mean score of 4.7840, 4.5160 and 4.5680 respectively. They also strongly agreed on the statement that they follow correct treatment procedures whenever the animal is sick as a way of ensuring their animal health as expressed by a mean score of 4.7440. They agreed to the fact that there are mechanisms to ensure traceability and that they always prevent occurrence of chemical residues in milk as expressed by a mean score of 4.1960 and 4.4080 respectively.

4.5 Animal Hygiene

The study sought to deduce extent to which animal hygiene influence the level of milk production. Findings are presented in table 4.9.

Table 4. 9: Extent to Which Animal Hygiene Influence the Level of Milk Production

	Frequency	Percent
Very low extent	10	4.0
Moderate extent	27	10.8
Great extent	75	30.0
Very great extent	138	55.2
Total	**250**	**100.0**

From the findings, majority of the respondents indicated that animal hygiene influenced the level of milk production to a very great extent as expressed by 55.2%. 30% of the respondents shown that animal hygiene influenced the level of milk production to a great extent. 10.8% of the respondents highlighted that to a moderate extent, animal hygiene influenced the level of milk production and 4.0% supported that to a very low extent animal hygiene influenced the level of milk production.

The study also sought to find out the level of agreement on various statement based on animal hygiene.

Table 4. 10: Level of Agreement on Various Statement Based On Animal Hygiene

	Mean	Std. Deviation
I use suitable and well maintained equipment for milking and storage	4.7640	.34202
Milk is harvested under hygienic conditions to prevent physical and microbiological contamination	4.6280	.29942
The milk man has undergone training on hygiene milk production	3.8880	1.02746
We practice good milking routines	4.5360	.47654
We ensure high cleanliness standards when handling the cows	4.7800	.56291
We follow good milking techniques	4.3640	.62052

The findings deduced that the respondents strongly agreed that they used suitable and well maintained equipment for milking and storage, milk was harvested under hygienic conditions to prevent physical and microbiological contamination and that they practiced good milking routines as this contributed to animal hygiene as expressed by a mean score of 4.7640, 4.6280 and 4.5360 respectively. They also strongly agreed that they ensured high cleanliness standards when handling the cows as expressed by a mean score of 4.7800. The respondents agreed that the milk man had undergone training on hygiene milk production and that they followed good milking techniques as expressed by a mean score of 3.8880 and 4.3640 respectively.

4.6 Animal Welfare

The study sought to determine extent that respect for dairy animal welfare influenced milk production as presented in table 4.11.

Table 4. 11: Extent That Respect For Dairy Animal Welfare Influenced Milk Production

	Frequency	Percent
Very low extent	9	3.6
Low extent	10	4.0
Moderate extent	83	33.2
Great extent	102	40.8
Very great extent	46	18.4
Total	**250**	**100.0**

From the findings, 40.8% of the respondents indicated that respect for dairy animal welfare influenced milk production to a great extent. 33.2% supported that to a moderate extent, respect for dairy animal welfare influenced milk production. It was also evident that to a very great extent, respect for dairy animal welfare influenced milk production as shown by 18.4% of the respondents. 4.0% of the respondents pointed out that respect for dairy animal welfare to a low extent, influenced milk production and that it influenced milk production to a very low extent as supported by 3.6% of the respondents.

The study also sought to explore the extent to which various statements influenced milk production of dairy cows.

Table 4. 12: Extent to Which Various Statements Influenced Milk Production of Dairy Cows

	Mean	Std. Deviation
Freedom from hunger	4.7300	7.72325
Freedom from pain	4.7400	.43951
Freedom from injury	4.6320	.55299
Freedom from thirst	4.8120	.47493
Free from discomfort	4.3720	.72921
Free from fear	4.9760	.52026
Protection against extreme climatic conditions	4.4480	.56620
Good sanitary conditions	3.9600	1.04823
Safe environment	4.1560	.92904

From the findings, the respondents indicated that freedom from hunger, thirst, and pain and injury to a very great extent influenced milk production of dairy cows as expressed by a mean score of 4.7300, 4.7400, 4.8120 and 4.6320 respectively. They also indicated that free from fear to a very great extent influenced milk production as shown by a mean score of 4.9760.The respondents also pointed out that free from discomfort, protection against extreme climatic conditions, good sanitary conditions and safe environment to a great extent influenced milk production as expressed by a mean score of 4.3720, 4.4480, 4.1560 and 3.9600 respectively.

4.7 Socio- Economic Management

The study sought to examine the extent to which socio- economic management of dairy animals influence milk production as shown in table 4.13.

Table 4. 13: Socio- Economic Management of Dairy Animals Influence Milk Production

	Frequency	Percent
Very low extent	10	4
Low extent	15	6
Moderate extent	40	16
Great extent	100	40
Very great extent	85	34
Total	**250**	**100**

According to the findings, 40% of the respondents indicated that socio- economic management of dairy animals influenced milk production to a great extent. 34% of the respondents shown that socio- economic management of dairy animals influenced milk production to a very great extent. It was also evident that socio- economic management of dairy animals influenced milk production to a moderate extent as supported by 16% of the respondents. 4% of the respondents pointed out that socio- economic management of dairy animals influenced milk production to a very low extent.

The study also sought to explore level of agreement based on attending exhibitions such as trade show as an avenue to gain knowledge which is important in enhancing milk production.

Table 4. 14: Level of Agreement Based On Attending Exhibitions Such As Trade Show as an Avenue to Gain Knowledge

	Frequency	Percent
Neutral	9	3.6
Agree	27	10.8
Strongly agree	214	85.6
Total	**250**	**100.0**

From the findings, majority of the respondents strongly agreed that attending exhibitions such as trade show was an avenue to gain knowledge which was important in enhancing milk production as shown by 85.6% of the respondents. 10.8% of them agreed and only 3.6% of the respondents were neutral.

The study sought to examine extent to which various statements influence milk production from dairy cows as presented in table 4.15.

Table 4. 15: Extent to Which Various Statements Influence Milk Production from Dairy Cows

	Mean	Std. Deviation
Level of knowledge in dairy animal keeping	4.6000	.55969
Access and allocation of funds	4.4040	.46823
Cultural practices	3.4040	.95311
Level of training in dairy animal keeping	4.6320	.55299

From the findings, the respondents indicated that level of knowledge in dairy animal keeping, access and allocation of funds and level of training in dairy animal keeping to a very great extent influenced milk production as expressed by a mean score of 4.6000, 4.4040 and 4.6320 respectively. It was also evident that cultural practices moderately influenced milk production as expressed by a mean score of 3.4040.

4.8 Regression Analysis

In this study, a multiple regression analysis was conducted to test the influence among predictor variables. The research used statistical package for social sciences (SPSS V 21.0) to code, enter and compute the measurements of the multiple regressions

Table 4. 16: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.8895	0.7912	0.7364	0.7296

R-Squared is a commonly used statistic to evaluate model fit. R-square is 1 minus the ratio of residual variability. The adjusted $R^{2,}$ also called the coefficient of multiple determinations, is the percent of the variance in the dependent explained uniquely or jointly by the independent variables. 73.6% of the changes in the level of milk production could be attributed to the combined effect of the predictor variables.

Table 4. 17: **Summary of One-Way ANOVA results**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.223	5	3.112	3.671	.001
	Residual	92.876	244	.641		
	Total	115.099	249			

The probability value of 0.001 indicates that the regression relationship was highly significant in predicting how animal nutrition, animal hygiene, animal health animal welfare and socio-economic management influenced level of milk production.

Table 4. 18: Regression coefficients of the relationship between level of milk production and the five predictive variables

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	1.492	0.298		4.218	0.044
	Animal nutrition	0.841	0.178	0.326	5.374	0.032
	Animal hygiene	0.702	0.171	0.421	4.963	0.027
	Animal health	0.596	0.563	0.123	3.916	0.038
	Animal welfare	0.703	.0725	0.384	4.115	0.018
	Socio-economic management	0.646	0.610	0.133	4.245	0.841

As per the SPSS generated table above, the equation ($\mathbf{Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \varepsilon}$) becomes:

$Y = 1.492 + 0.841X_1 + 0.702X_2 + 0.596X_3 + 0.703X_4 + 0.646X_5$

The regression equation above has established that taking all factors into account (animal nutrition, animal hygiene, animal health, animal welfare and socio-economic management) constant at zero level of milk production will be 1.492. The findings presented also show that taking all other independent variables at zero, a unit increase in the animal nutrition would lead to a 0.841increase in the scores of level of milk production and a unit increase in the scores of animal hygiene would lead to a 0.702 increase in the scores of level of milk production. Further, the findings shows that a unit increases in the scores of animal health would lead to a 0.596 increase in the scores of level of milk production. The study also found that a unit increase in the scores of animal welfare would lead to a 0.703increase in the scores of level of milk production

while a unit increase in the scores of socio-economic management would lead to a 0.646 increase in the scores of level of milk production. Overall, animal nutrition had the greatest effect on the level of milk production, followed by animal welfare, then animal hygiene, socio-economic management while animal health had the least effect to the level of milk production. All the variables apart from socio-economic management were significant at 5% level of significance and 95% level of confidence ($p<0.05$).

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presented the discussion of key data findings, conclusions drawn from the findings highlighted and recommendation made there-to. The conclusions and recommendations drawn were focused on addressing theobjectives of the study.

5.2 Summary of Findings

The study sought to establish the influence of animal nutrition, animal health, animal hygiene, animal welfare and socio- economic management of dairyanimals on milk production in Githunguri constituency, Kiambu County.

5.2.1 Animal Nutrition

The study established that animal nutrition to a very great extent influence milk production and aspects such as feeding animals on good quality feeds, preserving water supplies and feeds from contamination, ensuring quality assurance of feed supplier and ensuring good storage conditions of feed in the farm to avoid contamination which were seen as important to animal nutrition greatly influenced milk production.

5.2.1 Animal Health

The study sought to deduce that animal health to a very great extent influence the level of milk production. Aspects which were strongly agreed as factors influencing animal health and subsequent level of milk production include detecting animal diseases early, preventing spread of disease among animals and ensuring there are mechanisms to prevent transmission of zoonosis and following correct treatment procedures whenever the animal is sick as a way of ensuring their animal health.

5.2.3 Animal Hygiene

The study further established that animal hygiene to a very great extent influence the level of milk production. Various statements regarding animal hygiene which were strongly agreed upon as aspects that also influenced the level of milk production include use of suitable and well maintenance of milking and storage equipment, harvesting milk under hygienic conditions to prevent physical and microbiological contamination, practicing good milking routines and ensuring high cleanliness standards when handling the cows.

5.2.4 Animal Welfare

The study established that animal welfare to a great extent influence milk production. Freedom from hunger, freedom from thirst, freedom from pain, freedom from injury and free from fear to a very great extent influence milk production.

5.2.5 Socio- Economic Management

The study further deduced that to a great extent, socio- economic management of dairy animals influence milk production. It became clear that attending exhibitions such as trade show was an avenue to gain knowledge which was important in enhancing milk production. Level of knowledge in dairy animal keeping, access and allocation of funds, level of training in dairy animal keeping influence milk production to a very great extent.

5.3 Discussion

This section sought to discuss the influence of animal nutrition, animal health, animal hygiene, animal welfare and socio- economic management of dairy animals on milk production in Githunguri constituency, Kiambu County in the light of previous studies done.

5.3.1 Animal Nutrition

The study deduced that animal nutrition to a very great extent influence milk production. This is consistent with Arimi et al, (2000) arguments which state that proper nutrition is critical to enable modern, high-producing dairy cows to meet their genetic potential for milk production.

The study found out that preserving water supplies and feeds from contamination and feeding animals on good quality feeds influenced milk production to a very great extent. This is in line with Butler (2000) view that proper feeding management of the dairy herd can improve the cattle production efficiency and provide for a healthier cow. Feeding to increase production of milk with maximum levels of milk fat and protein is essential for achieving these benefits. An animal's health and productivity, along with the quality and safety of her milk, depend on the quality and management of the feed and water. Milk quality can be affected adversely by the quality of feeds they ingest. If the water is contaminated, the contaminants may cause milk safety and quality to suffer.

In addition these findings are in line with Muriuki (2012) argument that dairy farmers use professional animal nutritionists to develop scientifically formulated, balanced, and nutritious diets to support milk production, while optimizing nutrient management programs and minimizing pollution. Diets for cows include hay, grains, protein sources (e.g., soy) and vitamins and minerals. It is important to continually assess cows' nutrient intakes and their body condition as different weather conditions can influence their nutrient requirements. This is essential as it influence the level of milk production since poor nutrition is one of the major production constraints in smallholder systems, particularly in Africa and lack of certain minerals can result in: poor fertility, low milk production, deformed skeleton in young animals and metabolic diseases like milk fever or hypocalcaemia (Bhattarai, 2009). The study also deduced that the respondents didn't use chemical or toxin or prohibited ingredients.

5.3.2 Animal Health

The study revealed that animal health to a very great extent influence the level of milk production. This is backed up by Omore et al, (2005) who argues that dairy farmers depend on healthy cows for their livelihood. Adopting appropriate farm management practices such as milking hygiene, environmental sanitation, and regular veterinary care (e.g., periodic check-ups, prompt treatment of illness) of cows helps to assure the well-being of dairy cows and reduce their risk of infections such as clinical mastitis.

It was clear that most of the farmers detected animal diseases early, prevented spread of disease among animals, ensured there were mechanisms to prevent transmission of zoonosis and followed correct treatment procedures whenever the animal was sick. They strongly agreed that these aspects if ignored could lead to deterioration of animal health and influence level of milk production. This is in line with Bebe et al, (2003) views that animals should be observed regularly and proven methods used to aid in detection and accurate diagnosis of infectious diseases. The diseases should be treated by proven methods after accurate diagnosis to minimize the prevalence of infection. Also, sick animal should be isolated from the other cattle on the premises to minimize the spread of diseases. Appropriate procedures to separate milk from sick animals and animals under treatment should be followed to prevent further contamination. It is important to note that veterinary medicines are chemical and biological products sold for the treatment of animals where evidence of proven efficacy and safety have been examined by independent review bodies to ensure that the products are suitable for their purpose (Bhattarai, 2009).

5.3.3 Animal Hygiene

The study further found out that animal hygiene to a very great extent influence milk production. These findings are in line with Mosnier and Wiek (2010) view that it is important to ensure good milking techniques since incorrect techniques can result in a higher mastitis risk and injury to the cow which translate to lower level of milk production or even contamination of milk. It was strongly agreed that use of suitable and well maintenance of milking and storage equipment, harvesting milk under hygienic conditions to prevent physical and microbiological contamination, practicing good milking routines and ensuring high cleanliness standards when handling the cows were aspects that influenced the level of milk production. The respondents also agreed that undergoing training on hygiene milk production and following good milking techniques also influenced milk production. These findings are in line with Land O'Lakes (200) argument that quality of milk plays a very important role in ensuring that markets are accessible and that milk is able to be retained at retail level. This is because milk can be a carrier of life-threatening diseases. This is important because when dealing with issues of food safety, hygiene becomes paramount. In their quest to meet standard quality, some dairy farmers use a well-kept

cloth to clean and Vaseline to lubricate the udder before milking. This is their way of re-inventing and re-constructing the technology to suit their circumstances. Due to the fact that composition and food safety are the key aspects in the criteria for accepting milk, it is vital that all producers comply with the quality and safety procedures throughout the process from production and collection to processing and distribution.

5.3.4 Animal Welfare

The study found out that animal welfare to a great extent influence milk production. According to Muriuki, Wanjohi and Njuguna (2010), recognizing that proper animal care leads to the production of high quality milk, dairy farmers routinely employ many animal care practices such as providing cows with comfortable living conditions, nutritious diets, and good medical care. It is important to appreciate that dairy cows are very adaptable, and as long as they are given a healthy environment, they will grow and produce high quality milk.

It was also evident from the study that freedom from hunger, freedom from thirst, freedom from pain, freedom from injury and free from fear to a very great extent influence milk production. These is in line with Muchirii (2007) argument that farm animals also have 'desires', in relation to quality of life, such as companionship, space, and possibly variety in the diet thus the total environment must be entirely suitable for it to be worthwhile for the animal to expend resources on production and the competent operator should be able to recognize whether or not the animals are in good health, understand the significance of a change in the behavior of the animals, know when veterinary treatment is required and implement a planned herd health management programme. Animal welfare standards have been incorporated into most on-farm food quality and food safety schemes.

5.3.5.Socio- Economic Management

The study further found out that to a great extent, socio- economic management of dairy animals influence milk production. These are in line with Muriuki, Wanjohi and Njuguna (2010) view that the suggested good dairy farming practices for the socio-economic management of dairy farms are implementing effective and responsible management of human resources, ensuring

farm tasks are carried out safely and competently and management of the enterprise to ensure its financial viability. The study further deduced that attending exhibitions such as tradeshow was an avenue to gain knowledge which was important in enhancing milk production. This is in line with Doss (2006) argument that dairy farmers are not only able to participate in activities that lead to higher productivity, but also provide access for them to other pathways. Doss further suggests that as long as there is someone more educated in the household, production will be enhanced. The study also pointed out that level of knowledge in dairy animal keeping, access and allocation of funds, level of training in dairy animal keeping influence milk production to a very great extent. These is in line with the fact that access to knowledge means access to other benefits such as access to funds and that dairy farmers are not only able to participate in activities that lead to higher productivity, but also provide access for them to other pathways.

5.4 Conclusions

The study concludes that animal nutrition is essential to animal health which in turn influence the level of milk produced. It was also evident that practices such as preserving water supplies and feeds from contamination, feeding animals on good quality feeds, ensuring there are good storage conditions of feed in the farm to avoid contamination and having quality assurance of feed supplier influence the level of milk production.

The study further deduced that animal health to a very great extent influence the level of milk production. It was clear that detecting animal diseases early, preventing spread of disease among animals, ensuring there are mechanisms to prevent transmission of zoonosis and following correct treatment procedures whenever the animal is sick were aspects if ignored lead to deterioration of animal health and influenced level of milk production.

On the topic of animal hygiene this study concludes that animal hygiene to a very great extent influence milk production. It was clear that use of suitable and well maintenance of milking and storage equipment, harvesting milk under hygienic conditions to prevent physical and microbiological contamination, practicing good milking routines and ensuring high cleanliness standards when handling the cows were aspects of animal hygiene that influence the level of milk production. Undergoing training on hygiene milk production and following good milking

techniques also influence milk production.

The study further deduced that animal welfare to a great extent influence milk production. The study also deduced that freedom from hunger, thirst, pain, injury and free fear to a very great extent influence milk production.

The study further concludes that socio- economic management of dairy animals influence milk production and that attending exhibitions such as tradeshow acts as an avenue to gain knowledge which is important in enhancing milk production. Level of knowledge in dairy animal keeping, access and allocation of funds, level of training in dairy animal keeping also influence milk production to a very great extent.

5.5 Recommendations

(i) It has become evident that the use of professional animal nutritionists to develop scientifically formulated, balanced, and nutritious diets to support milk production, while optimizing nutrient management programs and minimizing pollution is very essential in enhancing animal nutrition and subsequent health of the animal. However this step or this decision to adopt one is very costly and demanding thus most of the farmers are unable to acquire their services therefore this study recommends that nutritionists or ministry of livestock devise strategies on how to reach the unable farmers who desire to expand in dairy farming but are frequently faced with problems related to nutrition. Most of them claim that they don't use chemical, toxin or prohibited ingredients but with nutritionist's help this may be false.

(ii) The study recommends that the farmers should be trained on how to know the behavior of animals and their reaction to various circumstances as most of them lack these skills. From the findings, it was evident that farmers had mechanisms to ensure traceability and prevention of occurrence of chemical residues in milk therefore this study recommends that the effectiveness and reliability of these mechanisms be examined.

(iii) This study recommends that farmers should be trained on the importance of quality and not just the amount of production as most concentrate on the amount neglecting quality

be it in milking or storage of milk. This stretches to quality assurance officers who should come up with strategies that will enable them ensure that all producers comply with the quality and safety procedures throughout the process from production and collection to processing and distribution.

(iv) This study recommends that the government should come up with strict guidelines that will enhance animal welfare and ensure equitable resource allocation and distribution. The farmers also be trained on how to allocate their resources to ensure that animal's welfare is enhanced.

(v) On the topic of socio-economic management, this study recommends that the government should invest more in tradeshow exhibitions as this acts as a training ground for most farmers who gain a lot of information from nutritionists and even from other successful farmers. This will also act as a breeding ground for creative ideas on how to enhance and revolutionize the world of dairy farming.

5.6 Suggestions for Further Studies

(i) Further study should be conducted on the influence of dairy farming practices on milk production in other counties in Kenya so as to allow for generalization of the findings.

(ii) Another study should be done to determine the influence of emerging trends on milk production.

(iii) A similar study should also be done on other farming practices such as beef farming.

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APPENDICES

Appendix I: Research Questionnaire

Kindly answer the following questions by writing a brief answer or ticking in the boxes provided.

PART A: BACKGROUND INFORMATION

1) Please indicate your gender. Male [ ] Female [ ]

2) How long have you practiced dairy farming ?

1 to 5 years [ ]

6 to 10years [ ]

11 to 15 years [ ]

16 to 20 years [ ]

21 years and above [ ]

3) Household head level of education Primary ( ) Secondary () Tertiary ( )
4) Farm size (acres)----------
5) How many cattle do you have on your farm? ----------
6) How many kg of milk are produced by your farm per day----------

PART B: ANIMAL NUTRITION

7) To what extent do you think nutrition of dairy animals influence milk production?

Very great extent [5] Moderate extent [3] Very low extent [1]
Great extent [4] Low extent [2]

8) What is your level of agreement on the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Animals are fed on good quality feed					
Water supplies and feeds are preserved from chemical contamination					
There is no chemical or toxin or use of prohibited ingredients					
There is quality assurance of feed supplier					
There are good storage conditions of feed in the farm to avoid contamination					

PART C: ANIMAL HEALTH

9) To what extent does dairy animal health influence the level of milk production?

Very great extent [5] Moderate extent [3] Very low extent [1]
Great extent [4] Low extent [2]

10) What is your level of agreement on the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I usually detect animal diseases early	\				
We normally prevent spread of disease among animals					
There are mechanisms to prevent transmission of zoonosis					
There are mechanisms to ensure traceability					
We always prevent occurrence of chemical residues in milk					
I follow correct treatment procedures whenever the animal is sick					

PART D: ANIMAL HYGIENE

11) To what extent does animal hygiene influence the level of milk production?

Very great extent [5] Moderate extent [3] Very low extent [1]

Great extent [4] Low extent [2]

12) What is your level of agreement on the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I use suitable and well maintained equipment for milking and storage					
Milk is harvested under hygienic conditions to prevent physical and microbiological contamination					
The milk man has undergone training on hygiene milk production					
We practice good milking routines					
We follow good milking techniques					
We ensure high cleanliness standards when handling the cows					

PART E: ANIMAL WELFARE

13) To what extent does respect for dairy animal welfare influence milk production?

Very great extent [5] Moderate extent [3] Very low extent [1]

Great extent [4] Low extent [2]

14) What is the extent to which the following influence milk production from your dairy cows?

	Very great extent	Great extent	Moderate extent	Low extent	Very low extent
Freedom from hunger					
Freedom from pain					

Freedom from injury					
Freedom from thirst					
Free from discomfort					
Free from fear					
Protection against extreme climatic conditions					
Good sanitary conditions					
Safe environment					

PART F: SOCIO-ECONOMIC MANAGEMENT

15) To what extent does socio-economic management of dairy animals influence milk production?

Very great extent [5] Moderate extent [3] Very low extent [1]

Great extent [4] Low extent [2]

16) What is your level of agreement with the statement 'Attending exhibitions such as trade show help one gain knowledge which is important in enhancing milk production'?

Strongly agree [ ] Agree [ ]

Neutral [ ] Disagree [ ]

Strongly disagree [ ]

17) To what extent do the following influence milk production from your dairy cows?

	Very great extent	Great extent	Moderate extent	Low extent	Very low extent
Level of knowledge in dairy animal keeping					
Level of training in dairy animal keeping					
Cultural practices					
Access and allocation of funds					

THANK YOU FOR YOUR PARTICIPATION