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DEPARTMENT OF SOCIOLOGY AND SOCIAL WORK

EFFECTS OF PATTERNS OF ADOPTION OF DAIRY FARMING TECHNOLOGIES AMONG SMALL-SCALE FARMERS IN GITHUNGURI DIVISION, KIAMBU COUNTY

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DECLARATION

The research project is my original work and has not been presented to any other institution of higher learning.

Signature……. ……

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DECLARATION BY THE SUPERVISOR

The Research Project Report has been submitted for examination with my approval as the University supervisor.

Signature……. ……

Dr. Beneah Mutsotso Date

DEDICATION

I wish to dedicate this project to my wife Beatrice and our children Lewis, Nilpher and Sylvia for their patience, encouragement, and support during the long hours spent in conducting this study.

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ACRONYMS

ADC	Agricultural Development Corporation
AFC	Agricultural Finance Corporation
AI	Artificial Insemination
CAIS	Central Artificial Insemination Services
DANIDA	Danish International Development Agency
EADD	East African Dairy Development
ERSWEC	Economic Recovery Strategy for Wealth and Employment Creation
FAO	Food and Agriculture Organisation
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GOK	Government of Kenya
ICRAF	World Agroforestry Centre
IDRC	International Development Research Centre
ILRI	International Livestock Research Institute
KARI	Kenya Agricultural Research Institute
KDB	Kenya Dairy Board
KEVEVAPI	Kenya Veterinary Vaccine Production Institute
KMC	Kenya Meat Commission
LSD	Lump Skin Disease
MDG	Millennium Development Goals
MOLD	Ministry of Livestock Development
NGO	Non- Government Organisation
OIE	World Organization for Animal Health
PRSP	Poverty Reduction Strategy Paper
SAP	Structural Adjustment Programmes
SRA	Strategy for Revitalizing Agriculture
STDs	Sexually Transmitted Diseases
UN	United Nations

ABSTRACT

The adoption of dairy farming technologies has contributed immensely to increased milk production, and can help to alleviate poverty and hunger, reduce the threat of diseases and ensure environmental sustainability in developing countries. Adoption of dairy technologies among small holder farmers is driven by the objective of the increased milk production for both home consumption and commercial purposes. However, farmers face serious constraints in nutrition, diseases control, cattle upgrading, general management and change in government policy. The specific objectives of this study were to find out smallholders receptability of adopting the new technologies; types, nature and patterns of adopting technologies; benefits accruing from adoption of technologies and factors that inform adoption or non-adoption of dairy farming technologies.

This study focused on three technologies farmers have adopted in dairy farming to increase productivity, namely: genetic improvement, feed management technologies and animal health care. The study was carried in Githunguri Division of Kiambu County, where sample size of 98 was selected.

The study findings show that a majority of the respondents keep Friesian breed of cattle as it produces the higher quantities of milk compared to the other breeds and therefore useful for commercial purposes and home consumption. On the feeding management, famers feed their cattle on fodder and supplement with feed concentrates to exploit the full potential of dairy breeds' capacity to produce more milk. Therefore technologies that enhance productivities are adopted to improve performance. The major challenge the farmers face in dairy farming is the high cost of the feed as fodder grown is inadequate. The study found that majority of farmers seek animal health care providers from qualified animal health providers. Scarcity of land was found a major challenge to milk production. The study recommends that farmers should be trained by Extension Agents on intensive farming technology to make use of limited land to produce more yields. There is need for the government to provide legal and policy frameworks that identify improvement of animal feed, animal health services and feed management of important activities in the dairy industries.

CHAPTER ONE

BACKGROUND TO THE STUDY AND PROBLEM STATEMENT

1.1 Background

In both developed and developing countries, dairy farming has socioeconomic effects. According to FAO (1995), livestock contributes to improved livelihoods worldwide, providing not only food but also non-food products, draught power and financial security. Livestock productions account for more than one third of the global agricultural GDP in developing countries and this proportion is expected to increase. Conventional technologies and biotechnologies in livestock have contributed immensely to increasing productivity, particularly in developed countries and can help to alleviate poverty and hunger, reduce the threats of diseases and ensure environmental suitability in developing countries. Philips (1989) classifies world dairy cattle production systems into two major groups. These are , first, dairy cattle production of systems in the developed world geared to high rates of production and dependent on expensive inputs. The second group systems are in the developing countries restricted to low productivity by a variety of constraints. Africa has been addressing problems and strategies on how to feed the growing human population (Hrabovszky, 1981). It is natural that they should also be addressing themselves to agriculture in order to provide sufficient employment opportunities and incomes for people who depend on agriculture for their livelihood. The strategies to increase production should look into investments, inputs, and technologies needed to bring about a change. Hrabovszky (1981) observes that the poorest people in developing countries depend on agriculture. To reduce income gap within these countries between the rich and the poor, focus must be on small farmers for whom income from livestock keeping is often a major component of their livelihood.

Small scale dairy farming dates back to the 1950s when restrictions on Africans to grow cash crops and practice large scale farming were removed by the colonial government. Chema (1983) states that grade dairy cattle farming was started in Kenya by European colonial settlers and it remained exclusively in the hands of the white settlers and was

guided by colonial policies formulated to benefit the white settler farmers at the expense of their African counterparts. The settlers imported some of the well known European breed of dairy cattle such as Ayrshires, Friesian, Guernsey and Jerseys and crossed them with the indigenous animals and, over the years, produced the present national grade dairy cattle herd (Chema, 1983). There has also been organized and orderly marketing of milk and milk products. Besides, as a result of dairy industry liberalization, there are now several institutions that are responsible for the organization and general development of the dairy industry in Kenya.

Adoption of technology has greatly contributed to economic development in both developed and developing countries. It reduces poverty and increases world economic wealth. It is for these reasons that most governments and companies invest heavily in technology transfer. Historically, technology has moved from one part of the world by the process of diffusion and has pervasive influence on the daily lives of the world's population (Teece, 1976). Man tends to extend his activities and satisfy his needs and wants through the adoption of technology. Most developing countries have acquired technologies from developed ones. However, most developing countries do not have good environments for technology transfer. They have limited resources, poor government policies, inadequate technology training centres, poor technology protection and negative attitudes towards technology. Hollard (1974) suggests that developing countries must create an enabling environment for technology transfer. The output from the technological transfer is not only physical components, but also local accumulation of technical knowledge and skills, which constitute the technological capability of the importing society (Quazi, 1983). The technology will provide sufficient employment opportunities and incomes for the people who depend on agriculture for their livelihood. In the Kenyan situation, public institutions, private ones and NGOs have disseminated technologies and knowledge transfer to the people.

Historically, to enhance the transfer the knowledge of dairy farming from the white farmers to the African people, the Kenya government through the Act of Parliament CAP. 346 of 1965 established the Agricultural Development Corporation (ADC), which was mandated to facilitate land transfer and maintain a livestock breeding programme.

Despite the existence of many agricultural technologies in Kenya, the dairy sector production continues to decline, coupled with rising levels of poverty, food insecurity and natural resource degradation (Muriuki, 2001)

1.2 Problem Statement

Dairy farming is an important sector in Kenya economy, generating income for the smallholders that produce more than half of the total milk production in Kenya (Omore *et al*, 1999) and create employment opportunities(jobs in rearing dairy cattle and selling milk and milk products) in rural and urban areas. The dairy sector constitutes an important component of Kenya's agriculture since it occupies about 47% of Kenya's arable land and provides a major source of livelihood for 625 000 smallholders (Omore, *et al* 1999). It contributes 26% of the GDP and a further 27% indirectly, with approximately 80% of the population deriving their livelihood from agricultural activities (GOK, 2006).

In most developing countries, the adoption of technology is a subject of increasing discussion. Developing countries are characterized by slow uptake of technology and the argument whether these technologies contribute significantly to alleviation of poverty or have positive socio-economic impacts is still on-going. According to Upton (1987), development and spread of new technology offers most hope of producing large increase in agriculture activities. However, Africa remains food insecure despite several research conducted by various bodies to develop new improved farm-level technology.

Previous studies on the dairy sub-sector have tended to focus on socio-economic aspects of livestock development, with little emphasis on adoption of dairy farming technology among smallholders. Mugivane's (1999) study focuses on roles of women in dairy livestock production in Vihiga District, showing women's participation and the gendered and unequal access to productive resources in small dairy industry. The main objective of Mugivane's study was to highlight the participatory roles of women in dairy cattle production. However, the study had little emphasis on the adopted farming technologies, receptability and availability of the technologies necessary for improving productivity in dairy production.

Baltenweck (2000), in collaboration with ILRI, focuses on determinants of adopting a high-grade cow by Kenyan smallholders. One of the factors affecting the dairy production is poor resistant common diseases. Mugivane (1999) found that grade dairy cattle's farming is more profitable than keeping indigenous cows where land is scarce. Although introducing a better class of animal is a good idea in improving milk production, its full potential will not be realized unless there is a simultaneous improvement in nutrition, disease control, general husbandry and project administration.

Wakhungu *et al* (2007), in a study of dairy farming in Vihiga District characterized grade dairy cattle with respect to household objectives and characteristics, production and managerial systems. They found that the production and calving performance parameters of grade cattle were low, limiting optimization of productivity under the different grade dairy cattle production systems.

This study focuses on three technologies farmers have adopted in dairy farming to increase milk productivity, as well as the availability to small dairy holders and their receptablitiy of these dairy-farming technologies. The study sought to examine socio-economic benefits accruing from adoption of dairy farming technologies. The study focused on the following technologies that farmers have adopted in their dairy herd for maximum milk production: genetic/breeding improvement (this is the utilization of genetic makeup responsible for milk production in exotic breeds and their crosses in order to get a cow with high potential for milk production.) The study concentrated on the use of AI services in improving the dairy herd). Nutrition provision (this refers to well feeding of the dairy cattle with required nutrients that will enhance livestock productivity).The study also focused on feeding management. Animal health care (refers to ensuring the dairy cattle health is maintained free of diseases and thus profitability of dairy farm is not negatively affected). The study focused on routine herd health and seeking of veterinary care. All these attributes, contribute to productivity and have ultimate effect on profitability.

1.3 Research Questions

1. What are different types of dairy farming technologies used by small scale farmers in improving livestock dairy production?
2. Which factors affect the adoption dairy farming technologies?
3. How does the adoption of dairy technologies affect the small scale farmers' livelihood?

1.4 Objectives of the Study

The overall objective of the study was to find out the effects of adoption of dairy farming technologies among smallholders.

The specific objectives of the study:-

1. To find out small holders' intentions and action on dairy farming technologies
2. To find out the types and patterns of adopting dairy farming technologies for increased milk production
3. To establish factors that inform adoption or non-adoption of dairy farming technologies
4. To examine the benefits accruing from adopting dairy farming technologies on the household

1.5 Justification of the study

The study is justified on the following grounds; First, to generate useful information on adopted dairy farming technologies by smallholder dairy farmers. The information will generate additional information on the already existing information on dairy farming technologies to dairy industry stakeholders. Secondly, the study provides information and a strategy on improving food security, improving household incomes and alleviating poverty through understanding the challenges and prospects facing the smallholders. According to Muriuki (2001), the Kenya dairy industry is dominated by smallholders and

greatly contribute livelihood of many people. About 625, 000 smallholder producer households are involved directly in milk production for market and about 25% of the households are involved in marketing. ILRI (1999), in a study of small dairy farming in Kenya generated research-based evidence of economic significance. It revealed that there are 35, 000 full-time jobs for both men and women in milk collection, transportation, processing and sales. Thirdly, the study creates general awareness of dairy farming technologies among interested groups involved in the dairy industry, namely policy makers, animals' nutritionists, veterinarians, sociologists, NGOs, dairy groups, research scientists, inseminators, farmers and consumers. This puts them in a better position when offering solutions and recommendations on the best way to implement dairy farming technologies. The information generated is useful in developing the dairy industry in line with Vision 2030 that recognizes livestock development. Indeed a country like Kenya where over 57% of people live below the poverty line and economic growth rates average 5% a year, a lot needs to be done by people of all sectors if the situation is to change (GOK, 2009).

1.6 Scope of the Study

The study focused on three adopted dairy farming technologies among small dairy holders; receptability, types, nature and patterns of adopting the technologies, benefits accruing from adoption and factors that inform adoption. The study also captures the characteristics of the adopters, the religion and social status.

1.7 Operational Definition of Terms and Concepts

Artificial Insemination: This refers to a technique by which semen is introduced artificially by a technician into the genital tract of the female at the time of sexual receptivity in an attempt to cause pregnancy.

Feed Concentrates: Feed supplement important in correcting certain nutrient deficiencies in forage and low feed intake in dairy cattle.

Genetic Improvement:	Utilization of exotic breed and their crosses genotypes or alleles present in an individual cow.
Productivity:	This refers to the ability of a farmer to increase milk yield in his dairy cattle. This is influenced by socioeconomic factors and availability of extension information
Small Dairy Holder:	This refers to a farmer who has a small parcel of land to practice dairy farming
Technology:	An idea, practice or object perceived as new by an individual.
Technology Adoption:	Continue full use of an idea as distinct from decision merely to try it, because of the benefits / advantages accruing from the technology.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review is under the followings sub headings; adoption of technology, areas of dairy farming technologies, agriculture extension services, accessibility of the technology to small dairy holders and the role of the government in Kenya in dairy industry.

2.2 Adoption of Technology

Rogers (1968) defines innovation as an idea, practice or object perceived as new by an individual, while diffusion is the process through which the new idea spreads from a source – its original invention by a creative individual to its adoption by users. Adoption implies a decision to continue full use of the idea as distinct from a decision merely to try it, because of the benefits / advantages accruing from adopting technology. Ogionwo (1982) argues that the more innovative the farmers are the better off the they become in terms of farm income and high level of living, implying that farmers with great resources are likely to take the risks involved in going over to a new practice. Rogers (1968) indicate that the relative advantage of innovation, that is positive related to adoption of the practice, could be economically profitable or the new idea minimizes the costs. Rostow (1960) argues that revolutionary changes in agricultural productivity are essential conditions for successful take-off of economic growth of society. Chitere (1994) concurs with this argument and indicates that the adoption of technology of the community members will definitely bring social change in a given community.

According to Chitere (1994) innovations could be introduced to a few members of a social unit, for example a rural village, then from these few members the innovations could diffuse, trickle down or be communicated to other members of the social unit. Chitere (1994) explains four factors which influence the diffusion process of innovations.

First, innovation-decision process is a series of mental stages where an individual becomes aware of new ideas to the time the idea is adopted. Hence, the stages, according to Chitere, are: ‘awareness’’ where an individual has heard of the new ideas; “interest” stage where he / she seeks more information about the new ideas; “persuasion” stage during which the individual compares the pros and cons of the idea; “trial” stage he / she tries out the idea on a small scale and, finally, “adoption” where the individual opts to use the new ideas as part and parcel of his / her ongoing operations.

The second factor is personal characteristics of adopters. Some individuals adopt innovations faster than others. Such individuals tend to take risks and are more open to new ideas. Rogers and Shoemaker categorise the adopters: “anxious innovators” who comprise about 2.5%, they try new ideas, take risks and have resources that enable them to adopt new ideas; “early adopters” about 12.5% who usually have more education and resources to enable them adopt new ideas, “laggards”(13%) who the last members of a community to adopt new ideas. They are usually less educated and with fewer resources for adoption of new ideas.

The third factor, on relative advantage, refers to the attributes of new ideas perceived as being better than the old idea that is replaced. An example can be seen in terms of economic profitability of savings in labour. The fourth factor the Chitere (1994) explains relates to the communication process of innovation, which refers to the transmission of information or messages from a source, for example agricultural agents, to a receiver / adopter, for example a farmer..

Okereke (1983) argues that adoption of technology involves application of mental and physical efforts directed to achieving a better value. Technology is a tool that provides better living conditions and enhances the capacity of the people concerned. It is a systematic application of scientific knowledge to practical purposes and includes inventions, innovations, techniques, practices and materials.

Farmers implement new ideas, improve practice and use research findings in order to boost their productivity in livestock. Dairy cattle farming in Kenya was introduced by European white colonial settlers who imported the exotic breeds, mainly the Ayrshires,

Freisians, Guernsey and Jersey. These breeds were later crossed with the indigenous cattle and over the years produced the national dairy cattle herd (Chema, (1983). According to Peeler and Omare (1997), the dairy cattle population is estimated to about 3 million. In dairy sector, the milk produced in Kenya is primarily from cattle, which contribute about 84%, with rest from 12% camel, and goats 4%. The major types of cattle kept are improved exotic breeds and their crosses (60%) and indigenous zebu (24%) from the communities in drier parts of the country (GOK 1989).

However, market oriented dairy farming is concentrated in the high potential areas in Kenya where good feed supply and disease control is much better. Dairy production can be classified into large or small scale. The small-scale dominate, owning 80% of the 3 million dairy cattle which consists of purebred Friesian, Ayrshire, Guernsey, jersey and their crosses that produce more milk than the indigenous breed contributing 80% of the marketed milk.

2.3 Agriculture Extension Services

Dahama and Bhatnagar (1987) define extension as education applied on behavioural science, the knowledge of which is applied to bring about desirable changes in the behavioural complex of human beings, usually through various strategies and programmes of change and applying the latest scientific and technological innovations. Extension education aims at dissemination of useful and practical information relating to a sector of development such as agricultural extension and livestock extension aimed at improving productivity. Agricultural extension is a program geared towards learning rather than teaching paradigm. Morris (1999) indicates that agricultural extensions promote agricultural technologies to meet farmers' needs. The extension education brings desirable changes in the quality of life of the target group that it serves by helping them to change their attitudes, knowledge, skills and resources such as land, pasture, water and livestock. According to Okereke (1983), extension services involve teaching, research and transfer of new technologies and information to farmers using different media like radio, television, or newspapers.

Madukwe (2006) describes three approaches used by extension agents in passing of agricultural technologies. These are, first, extension-farmer contact, which refers to a situation where an extension officer contacts a farmer on a one to one basis passing on agricultural information. Although method is very effective, it is expensive and has narrow spectrum. The second approach is the farmers' group, which refers to passing of agricultural technologies to farmers in organized groups who are interacting together towards achieving a common goal. The farmers form a group supporting one another to learn and adopt technology, hence amplifying extension process. In this method, extension agents not only impose outside technologies but also act as catalysts and mobilize of farmers in recognizing local innovations, helping to assess and encourage adoption of technologies. The approach enhances the dissemination of information to a wider spectrum of users.

The third one is called the Farmer field School Approach, where farmers meet periodically with facilitators. It is a participatory method of technology development and dissemination based on adult learning principles and experimental learning, hence facilitates farmers' demand for knowledge and offers an opportunity for the end users to choose, test and adapt technologies according to their needs. The approach reflects the four elements of experiential learning cycle; 1) concrete experience, 2) observation and reflection, 3) generalization and abstract conceptualization, and 4) active experimentation.

Anderson and Feder (2004) argue that investments in extension services have the potential to improve agricultural productivity and increase farmers' incomes especially developing countries where more than 90% of the world's nearly one million extension personnel are located. According to Muyanga and Jayne (2006), a consensus exists that extension services, if functioning effectively, improve agricultural productivity through providing farmers with information that helps them to optimize their use of limited resources.

The ultimate objective of livestock extension education is the development of livestock farmers by improving their living standards through bringing desirable changes in attitudes, skills and knowledge about recent technologies and their applications. The livestock extension education plays an important role in empowering the farmers with appropriate technological knowledge and skills through various forms of extension education and training programmes.

In dairy farming, the extension personnel educates dairy farmers / producers on the best way to use to improve livestock productivity. The extension agents demonstrate new technology and teach better management practices to dairy farmers through farm visits, newsletters, meetings, seminars and field days (Land O'Lakes, 2008). The extension agents include the veterinarians who advise farmers about general animal health problems provide health services and care. They also offer reproductive and health programme and animal feed consultants who advise farmers on animal nutrition and feeding programmes. Dairy technologists educate farmers on dairy products processing and value addition.

2.4 Areas of Technology Application

2.4.1 Genetic Improvement

Every dairy farmer desires to have a high producer cow in terms of yielding milk enough for his family and for commercial purposes, besides high conception rates (Wattiux, 1992). Farmers acquire such cows by buying a genetically developed cow or genetically improving their existing cows with the aim of getting a cow that will produce more milk. However, according to Baltenweck (2000), buying a high dairy producer is very expensive and most smallholders cannot afford. However, small dairy farmers can still get high producers cattle through genetic improvement of their existing herd.

Wattiux (1996) defines genetic improvement in cattle as utilization of exotic breed and their crosses genotypes (genetic makeup) or alleles (genes) present in an individual cow that are responsible for high milk production. The production of milk requires the action

of numerous genes, each responsible for a specific aspect of milk synthesis. These include:

1 Genes responsible for the synthesis of the secretory tissues in the udder.
2 Genes responsible for the blood supply to the udder.
3 Genes involved in the capacity of the cow to digest and metabolize food.

In addition to the action of the genes, synthesis of milk requires availability of the building blocks of milk components (protein, glucose, minerals, fat and vitamins) which come from the digestion and metabolism of the feeds, thus feeding influences milk production.

According to Mendel (2000), these alleles are located in sex cells, which are transmitted during fertilization. Cattle with superior genes of high milk potential production should therefore, be used for upgrading the existing dairy herd. The dairy cattle (both exotic breeds and their crosses) population in Kenya has now grown to an estimate of 3 million (Peter & Omare, 1997).

2.4.1.1 Artificial insemination (A I)

This is a technique by which semen is introduced artificially by a technician into the genital tract of the female at the time of sexual receptivity in attempt to cause a pregnancy (Wattiaux, 1996). AI was pioneered by a Russian scientist working with horses and was first used by Danish breeders on large scale in dairy cows. The method is currently practiced in Kenya and with liberalization of the dairy industry in 1992; the AI service was fully privatized. The semen is packed in plastic straws and stored in a liquid nitrogen refrigerator maintained at – (196^0c). This technique is performed by a technician who has special training and understands the steps involved in the procedure. All these costs are now incurred by the farmers, so it has become very expensive for an ordinary small dairy farmer.

According Chamberlain (1989), improvement through breeding aimed at increasing milk yields has been very low in developing countries due to poor implementation of

government policy in breeding, lack of proper national herd recording system and local breeds, which are genetically poor for milk production.

AI provides opportunities to choose sires that are proven to transmit desirable traits in a dairy cow population. AI eliminates the costs and the risks of maintaining bulls on the farm. It minimizes the risk of getting offspring with undesirable traits. It also provides the opportunity for providing sires at a good age. Thus, the genetic make-up of a proven sire is known with a certain degree of confidence, but that of a bull on the farm is usually unknown. AI further minimises the risk of spreading STDs. The benefits of AI are offered cumulatively over generations of cows. The genetic value of cows increases rapidly over time as a result of intensive selection from one generation to the next.

Artificial insemination requires a large degree of cooperation between the breeders, the technicians, the insemination countries and the breeding associations. Although a number of farmers are using AI especially in high potentials areas, a big number farmers do not know of the existence and importance of AI service, which is advantageous over natural method. Some people unfortunately believes that the AI conception rates are low, and that the calves resulting from AI are physically weak and cannot withstand the harsh conditions. Radostits, et al (1983) indicates low conception rates are mainly contributed to by ignorant farmers who are unaware of details, or failure to know the signs of a cow on heat and poor timing of AI service. Therefore to increase the conception rate, it is necessary to educate farmers on heat detection so that cows can be served at the right time.

In Kenya, dairy breeding started in 1920 with formation of Kenya Stud Book that kept the upgrading register. In 1946, CAIS was established with the objectives of semen production and catering for formation dairy recording services of Kenya. In 1969 the national artificial scheme was launched, which covered three quarters of all high potential small holders areas with the main objective of supplying dairy farmers with better quality breeding stock through AI. In 1992 the government, under external pressure and budgetary constraints, liberalized the dairy industry including privatisations of the AI

services. Since then, AI has become expensive and unaffordable to majority of smallholders. This has led to continuation of use of natural methods, whose disadvantages by far outweigh the advantages. It is expensive to keep a bull; there is likelihood of STDs transmission and high chances of physical injuries to the animal and to the farmer by a bull (Wattiux, 1996).

2.4.2 Nutrition

The state of feeding technology of dairy cattles, especially in developing countries, is wanting. According to Njarui *et al* (2009), whose case study on feeding management of dairy cows cited inadequate nutrition as a major constraint that negatively affects the growth and viability of dairy farming. A well-fed animal will grow faster, reach reproduction stage early and produce more milk, remain in good health status and maintain good body condition. Henderson (1977) suggests that dairy animals require certain foods for body maintenance and for production. The maintenance ration varies with breed and size of the animal, whereas production ration is required by dairy cattle for milk production.

Dairy cows that produce more milk will therefore require more and richer amounts of food. These are in form of fodder (grass), legumes and other edible plants. In pastoral areas, grass is the most available, cheap and best to feed cattle. To enhance milk production, dairy cattle are also supplemented with concentrates and mineral salts. These are important in correcting certain nutrients deficiencies in forages and low feed (fodder) intake. The availability and prices of concentrates are variable especially in developing countries where animals are competing with man for food. The emphasis should be placed on home-made or village-produced processing by-products rather than on commercially compounded feeds.

In Kenya, a majority of smallholder's farmers keep more animals than they can feed from their own land. Estimates by Reynolds *et al* (1999) show that smallholder farmers produce about 70% of the feed from their own resources.

Dairy cattle must be provided with water throughout. Water comprises 70% of the lean animal body and is an active structural constituent. It is important in body metabolism, digestion and secretion. According to Merck (1991), dairy cattle suffer more quickly from an inadequate water intake than from deficiencies of any other nutrient. Milk production and feed intake will be depressed if free access to water is not allowed. However, most smallholders do not have a reservoir for water, others fetch the water from river causing extra labour cost; this may be straining in providing enough water to dairy cattle. This can be improved by enhancing rainwater harvesting into roof water catchment tanks.

Henderson *et al,* (1983) indicates that fodder is the major component of the feed of the dairy cattle. It is cut from the growing areas and sun-dried and then fed to the cows as dry matter. It provides the cow with energy, proteins, minerals and vitamins. This includes hay (dried grass), maize stocks, sorghum stock, oats, Napier grass, legumes, Lucerne and kales. Grass can also be grown and grazing management systems applied to ensure maximum utilization of the grown grass. Small scale holders will therefore be required to grow fodder in their available farms to feed their cows. However, farmers in urban areas, because of their limited size of land, will be required to source the fodder elsewhere – most likely will buy in the surrounding areas.

In order to maintain productivity for the dairy cattle, especially the dry seasons, smallholder dairy farmers need to improve feed availability. However, it is obvious that no Kenya farm can be correctly stocked for all times of the year Mugivane,(1999). Smallholders, due to limitations of land, finances and increased population pressure, do not grow enough for their cattle through the year. However, extension officers advise and show farmers method to preserve the feed during the time it is in excess so that there is adequate feed during dry seasons.

The most common method of fodder conservation is silage making. By this method green food is preserved with relatively slight losses, it is the process that if carefully carried out, will provide a succulent feed for stock when dry conditions prevail and little

or no succulent food is available. Silage making is a process within the capacity of any farmer no matter how limited their facilities may be (Henderson *et al,* 1983).

Hay making is another way of preserving feed. It involves a reduction in the moisture content of a cut green crop / grass by natural means, until it can be stored in bulk without the risk of spoilage by fermentation mould growth (Henderson *et al* (l983). The making of hay and storing is a very valuable means of preserving dry weather feed, and the quality of hay depends on nutritive value of the original material use.

Due to increasing population pressure on the arable land for dairy farming, cattle are being confined in a stall and fed there all year. There is minimal movement of cattle because they are not allowed grazing in the fields. The model is useful in areas where there is shortage of grazing land, low productivity of dairy cows and high prevalence of diseases. However, this requires an increased level of labour needed in cutting the fodder and cleaning the stall (Mugivane, 1999).

2.4.3 Animal Health Care

In both developing and developed countries, animals' diseases, parasite infestation and public health problems constitute a major problem to livestock production and safe utilization of animals' products. Disease outbreaks, especially the contagious and zoonotic types, lead to serious socio-economic consequences such as production losses, loss of livelihood, food insecurity, poverty, restriction of marketing opportunities and public health risks. Globally, the OIE (World Organisation for animal health) insist that animals for trade must be in good health and free from contagious diseases to the people or to other animals.OIE ensures safety of international trade of animals and their related products by issuing harmonised sanitary guidelines on international certification and disease control methods to minimize adverse economic losses and human deaths (OIE, 2006). This promotes international trade in animals and animal products by ensuring scientific based standards are met. However, most developing countries have social and economic pressing problems which mean that animal's diseases control policies can only be implemented when the diseases cause serious losses and threaten the lives of the people.

The diseases affecting dairy cattle can be classified as metabolic diseases, infectious, chemical conditions and parasitic infestation (both external and internal parasites) (Radostits, 1983). Prevention and progressive control of the disease is very important, especially to those that occur as outbreaks such as the FMD, LSD, Anthrax and Rift valley fever. Such diseases cause major food shortages, destabilize markets and trigger trade measures. Massive vaccinations of cattle against preventable diseases and imposing quarantine in case of outbreaks, and bio-security control measures are used to contain the zoonotic and spread of diseases that can result to heavy economic losses.

2.5 Accessibility of Dairy Farming Technologies in Kenya to the Small Dairy Farmers

According Muriuki (2000), the contribution of dairying to the sustainability of smallholders through its roles in nutrient cycling, employment creation and provision of farm household nutrition makes it an easy choice vehicle to address rural poverty. However, smallholder dairying is constrained by many factors that include feed scarcities, disease challenges, poor infrastructure such as rural road access and water electricity, slow legal and policy reforms.

Before liberalisation of dairy industry 1992, the government used to provide the small farmers with free services or at very low fee. However, with increased budgetary constraints resulting to the crises in the 1970s and early 1980s, and the global pressure to the developing countries to implement policies and institutional and restructuring reforms (SAP's), the government changed its involvement in small scale farm support initiatives (Ngigi, 2002). Hence, the decontrol of milk prices (1992), and the privatisation of AI services (1991), privatisation of clinical services (1994), and implementation of the cost sale of veterinary drugs, were some reforms meant to create enabling dairy industry environment with less government interventions (Omiti, 2002). However, these measures meant that farming has become expensive and unaffordable to most dairy smallholders. Chamberlin (1989) indicates that poor implementation of breeding programmes in developing countries has resulted to low milk yield. The high cost AI services, which are not affordable to most dairy smallholders, deny the farmers opportunities to use

improved and superior semen to upgrade their dairy herd, hence tend to use of natural method which is even more disadvantageous compared to AI service. The unavailability and high cost of clinical services has led to increased cattle diseases prevalence, reduced productivity or even death of dairy cattle.

There is generally poor adoption of technology, leading to lack of adequate feed resources and, where available, in seasonal and poor quality, leading to low adoption technology in feed conservation and thus use of inappropriate feeding regimes. Although most of these technologies have been researched on, and are simple to apply, they remain unutilised at farm level, due to poor dissemination (Karanja, 2003). According to Winrock (1992), the low quality and quantity of feed resources is the greatest constraint to improving the productivity of livestock in Sub-Saharan Africa. There is a high cost of cattle feed concentrates because of competition with the human population. In 1993, the government formulated dairy development policy to guide the industries towards a liberalised market economy (GOK 1989) aimed at ensuring availability of credit to farmers, harmonisation of breeding services, and improvement of dairy feeder roads.

These transformations to the private sectors who are driven by profit making, has led to farmers experiencing serious challenges in upgrading their herd, proper feeding and diseases control. Small dairy farmers face constraint in marketing of the dairy products. At production levels, farmers find themselves with milk that cannot find dependable market outlets (Karanja, 2003). The farm market price is low and is determined by the processors. Some farmers in the country have called on the government to review milk production prices or else milk would soon become a luxury item affordable only to the rich (Danida, 1991).

Poor infrastructures such as poor roads make transport of milk to the market and picking of animal feeds difficult, and increasing the cost of transport through vehicle repairs. Lack of electricity used by milking machines, feed cutters and refrigeration also pose challenges that prove too costly to farmers. The situation is compounded by the general

lack of cooling centres necessary for keeping milk fit for human consumption and factory processing.

2.6 The Role of the Government in Dairy Industry Technology

The roles of government have been classified under three sub-headings, namely: legal framework, policy framework and institutional framework.

2.6.1 Legal and Regulatory Framework

The government sets the legal framework that guides the dairy industry. The regulations as mandated by the government attempt to produce or prevent outcome in different timescale that would otherwise occur. According to Vashisht (2003), regulations are set to control market entries, prices, wages, pollution effects, employment and standards. The laws that govern the dairy industry are organised as follows:

2.6.1.0 The Legal Framework

These include Animals Disease Act, Dairy Industry Act, the Co-operatives Act, Standard Act, Public Health Act and the Agricultural Development Corporation Act.

2.6.1.1 Animal Disease Act, Cap 364 (1964)

This Act provides the Veterinary Director with the following powers:

1. Declare areas infected, issue provisions affecting infected areas, search for infected animals
2. Prohibit importation of animals, slaughter and disposal of forfeited animals and carcasses of infected animals.
3. Prescribe fees for drugs and vaccines or prohibit use of vaccine or drugs.

2.6.1.2 Dairy Industry Act, Cap 336

This Act of parliament was enacted in 1958 to provide the improvement and control of the dairy industry. The Act provides establishment of the Kenya Dairy Board that is mandated to promote and regulate the dairy industry.

2.6.1.3 Standard Act, Cap 496

This Act of parliament was established in 1974 to promote the standardization of the specification of commodities, and to provide for the standardization of commodities and codes of practice. The Act provided for the establishment of the Kenya Bureau of Standards, which promotes the standardization of dairy industry.

2.6.1.4 Public Health Act, Cap 242

This Act of parliament commenced 6th September 1921 and makes provision for securing and maintaining health. In the dairy industry, the Act has provision for milk handling. The Act provides that milk and milk products for sale must be free from contaminants such as debris, harmful chemicals, drugs and disease particles, especially zoonotic diseases. The Act provides also that persons handling milk must be free from any contagious disease.

2.6.1.5 Agricultural Development Corporation Act, Cap 445 (1965)

This Act of parliament provides for the establishment of the Agricultural Development Corporation (ADC) and for connected purposes. ADC acts as the custodian of the national livestock studs and ensures the continued existence of pedigree breeds, and of the availability of quality stock to the Kenyan farmer at affordable prices. ADC plays a major role in the transfer of technology from research institutions to the Kenya farmers through organised training such as field days, seminars and through the media.

2.6.1.6 The Co-operative Societies (Amendment) Act, Cap 490 (1966)

The Act provides for the establishment of co-operatives. It enables the dairy farmers to form cooperatives or societies that promote development and represent their interests. The Act also gives power to the members of co-operatives to appoint a commissioner who is charged with the responsibilities for registering all co-operatives and societies, provided they fulfil the basic requirements as stipulated by the law and to provide guidelines into the registration and the running of co-operatives.

2.6.1.7 Regulatory Boards

2.6.1.7.1 Kenya Dairy Board

This is the main regulatory board in the dairy industry established under the Dairy Industry Act, Cap 336 of the Law of Kenya. KDB has the responsibility of developing, promoting and regulating the dairy industry. The main functions of KDB are enforcement of national standards of the dairy industry, training for the industry, facilitation of stakeholders, maintenance of a databank for the dairy industry and regulation of imports.
Other functions of the KDB are:

1) Enforcement of the Dairy Industry Act
2) Organise, regulate and develop efficient production, marketing, distribution and supply of dairy produce required by different classes of consumers
3) Regulate the sales of raw milk and importation of dairy produce
4) Encourage proper use of milk containers for transportation and storage facilities
5) License milk producers and processors to permit a high degree of private enterprise in production and processing of dairy products

2.6.1.7.2 The Kenya Bureau of Standards

The KBS is a statutory body charged with enforcement and promotion of national standards for the dairy industry and certification of quality standards of all dairy products and services, control of standardization mark, facilitation of stakeholder's activities and maintenance of a databank for the industry and regulations of import. KBS provides facilities or arranges for the testing of milk, milk products and material used in milk handling.

As a statutory body, it provides the cooperation with the government, farmers' representatives or local dairy farmers themselves with a view to securing the adoption and practical applications of standards.

2.6.2 Policy Framework

The overall goal of the Government of Kenya is to eradicate poverty, illiteracy and diseases while creating wealth. Kenya is also signatory to the MDG programme of the UN, whose first goal is to halve the hunger incidence by the year 2015. Livestock being

the mainstay of most rural people is key in the achievement of MDGs. It is against this background that the government seeks to put in place a conducive policy environment to facilitate enhanced and sustainable growth of the livestock sub-sector (GOK, 2008). The Government of Kenya further recognizes the role that a vibrant livestock industry plays to reverse poverty levels and contribute to the nation's economic growth. This recognition has been emphasized in various government policy documents, such as the liberalization of the dairy industry policy, National Development Plan 2002–2008, Poverty Reduction Strategy Paper (PRSP), Economic Recovery Strategy for Wealth and Employment Creation (ERSWEC), Strategy for Revitalizing Agriculture (SRA) 2004–2014, Economic Recovery Stimulus (ERS), National Livestock Development Policy and National Development Strategy Long Term Plan 2008-2030; all in the line of MDGs of contributing to food security, protection of the environment and establishment of global linkages.

2.6.2.1 Liberalization of Dairy Industry 1992

Rostow (1960) argues that commercialization of agriculture, spread of new techniques in agriculture and farmers acceptance of new methods would bring the changes in ways of their lives. The Kenya government in fulfilment of the SAPs liberalized the dairy industry. This involved liberalization of dairy processing, veterinary services and artificial insemination services to enable the private sector to efficiently participate in the dairy industry development. The clinical services and A I services in the potential areas is now in the hands of the private sector. Also, as result of liberalization of milk, processing and decontrol of milk price there are now forty-five private creameries licensed countrywide for the milk production (GOK, 2008). According to a study done in 2010 by ILRI, ICRAF, Norwegian of International Institute and Qatar researchers on Kenya dairy policy change, 855 of milk vendors have recognised the importance of milk value chain. The Kenya Dairy Board and the Public Health Department have been training milk handlers on quality control and hygienic ways of handling milk.

2.6.2.2 The National Development Plan 2002-2008

The National Development Plan ties with the objectives of the Vision 2030. The plan aims at: (1) increasing livestock products through provision of widely accessible inputs and services to farmers; (2) financing investment in the livestock sector; (3) increasing market access to livestock and livestock produce and, (4), enhancing institutional efficiency and effectiveness in services delivery.

2.6.2.3 Economic Recovery Strategy for Wealth and Employment Creation (ERSWEC) 2003-2007

ERSWEC was put in place in order to reverse decades of slow and stagnant economic growth that had adversely undermined the well-being of Kenyans. The policy classified dairy industry as a productive sector that is dominated by small-scale holders who produce 80% of the milk consumed in the domestic market, hence the need to improve the sector by undertaking the following measures: (1) Develop a clear policy on milk production, processing and marketing emphasizing on health and safety standards; (2) promote animal health by reactivating and expanding dipping, breeding and clinical services including monitoring and control of animal diseases; (3) Support the development of facilities for milk handling such as collection and cooling centres and, (4) encourage establishment of value adding processes.

2.6.2.4 Strategy for Revitalizing Agriculture (SRA) 2004-2014.

SRA was prepared with overall objectives to raise household incomes, create employment and ensure food and nutrition security. The policy strategically aimed at: (1) Improving delivery of research, extension and advisory support services; (2) Reviewing and harmonizing the legal, regulating and institutional framework; (3) Restructuring and privatising non-core functions of parastatals; (4) Increasing access to quality farm inputs and financial services; (5) Taking measures to improve access markets such as construction rural roads and, (6), Formulating food security policy and programs.

2.6.2.5 National Livestock Policy (2008)

The National Livestock Policy (2008) was developed to address the challenges and shortcomings arising from the liberalization policies implemented by the government in 1990s. It covers issues relating to farm genetic resources; livestock nutrition feed inputs, animal disease and pests, livestock marketing, food safety, veterinary pharmaceuticals, quality assurance, research extensions and food security.

2.6.2.6 National Long-term Strategy for Social, Economic and Political Development 2008 – 2030

This strategy, commonly referred as Kenya vision 2030, is the government development's strategy and economic blueprint for developing the country to a medium earning class by 2030. Vision 2030 identifies the vision for agriculture and livestock sectors as innovative, commercially-oriented and modern farming by:- (1) Reforming institutions through transforming key organizations such as cooperatives, regulatory bodies and research institutions into complementary and high performing entities that facilitate growth. (2) Increasing productivity through provision of inputs and services to farmers; (3), transforming land use to ensure better utilization of high and medium potential lands and, (4), increasing market access through value addition by processing, packaging and branding of livestock and agricultural produce.

2.6.3 Institutional Framework

The dairy industry falls under various ministries; Ministry of Livestock Development, Ministry of Co-operatives and the Ministry of Trade (GOK, 2008). Other supporting ministries include Ministry of Agriculture, Ministry of Finance, Ministry of Energy and the Ministry of Roads and Public Works.

2.6.3.1 Ministry of Livestock Development

The Government of Kenya mandates Ministry of Livestock Development to promote, regulate and facilitate livestock production for socio-economic development and industrialization. Its objective is to enhance food security and safety, generate income, create employment, and enhance socio-economic development. MOLD is composed of two technical departments, namely the Department of Livestock Production and

Department of Veterinary Services. Its core institutions include the Kenya Dairy Board, KEVEVAPI, CAIS and KMC.

The Department of Livestock Production is responsible for the management and conservation of the genetic resources base, development of appropriate policy and legal framework, development of local international marketing networks, value addition in livestock products, processing and agribusiness, quality assurance for livestock feeds and collaboration with research institutions and other stakeholders in technology development.

The Veterinary Department is charged with the formulation, implementation, monitoring and evaluation of animal health related strategies, policies and legal framework management, control and eradication of diseases and pests, provision and facilitation of extension services in animal health. The core institutions are:

2.6.3.1.1 The Kenya Dairy Board

The Kenya Dairy Board regulates the dairy sub-sector. It facilitates stakeholders of activities towards a sustainable dairy industry that provides quality and co-operative milk and milk products. These include capacity building activities to the farmers, milk transporters promotion of dairy extension services, ensuring the high standard of milk handling, is maintained.

2.6.3.1.2 KARI

KARI is public organization that undertakes research issues affecting the agricultural sector in Kenya. The institute is actively engaged in projects focusing on key issues, including control of cattle diseases such as tick borne diseases, development of forage production and new varieties of forage such as disease-resistant Napier grass.

2.6.3.1.3 KEVEVAPI

KEVEVAPI is a government institute that produces veterinary vaccines; co-ordinates and takes charge of all veterinary vaccines in the country. The institute researches either alone

or in collaboration with other research institutions in the innovation of veterinary vaccines production. It also markets and distributes veterinary vaccines locally and abroad.

2.6.3.1.4 CAIS

CAIS is a government parastatal that produces and distributes high quality proven bull semen in seven regions in the country, mostly in high potential areas. It regulates and supports delivery of AI services and markets bull semen through a network of inseminators. CAIS also controls and conserves genetic resources and dairy recording services.

2.6.3.2 Ministry of Roads

The Government of Kenya recognises the importance of infrastructure in spurring economic development as a component of a sound business environment. The government has established Kenya Rural Roads Authority responsible for development of rural and small towns' roads of classes D, E and others (GOK, 2010). According to the World Bank (1995), building and improving roads in rural areas facilitate the growth of agricultural investment and ease the accessibility to health centres. During the implementation of ERSWEC 2003-2007, twenty-nine road projects covering 3, 000 Kms were completed, besides ongoing road works (GOK, 2010).

2.6.3.3 Ministry of Energy

The rural electrification programme launched in 1973 has enabled small dairy farmers to access electricity used in refrigeration and pasteuralization of milk, electric milk machines and electric fences which provide security for the farmer and animals. The electric fences are cheaper and safer than the conventional use of barbed wire (Foley, 1990).

2.6.3.4 Ministry of Cooperative Development

The Government of Kenya is involved in marketing of farmers of milk through its parastatals, the New KCC, which collects milk form the farmers, processes and sells to

the consumers. This has benefited farmers, especially in areas where private dairy processors have not been reached.

2.6.3.4.1 Agricultural Finance Corporation

The Government of Kenya, through the AFC has been providing credit facilities to smallholder's farmers at low interest rates and cancelling debts owed by farmers in some circumstances. The role of the AFC is to assist the development of agriculture and agriculture industries by providing loans to individual farmers, group of farmers, private companies, public bodies, local authorities and other persons engaging agriculture and agriculture industries. The loan scheme for dairy production is designed for individuals or groups and the repayment period ranges between 2 to 5 years. Access to financial services to the farmers has increased significantly over the years. Following the revival of the AFC, loan disbursement to farmers has increased from KShs 90.7 million in 2002/03 to KShs 1.79 billion in 2006/2007 (GOK, 2010).

2.7 Theoretical Framework

The study employs two sociological theories in an attempt to understand adoption of dairy farming technologies among small dairy farmers.

2.7.1 Diffusion of Innovations Theory

Everett Rogers (1968) is the main proponent of this theory. He describes innovations as an idea perceived as new by an individual, and which spreads by the process of diffusion through the essence of human interactions. The diffusion of innovation has four elements of analysis. (1) The innovation as perception of the new idea. (2) Idea communication / diffusion as an element that spreads from its invention or creation to its ultimate users or adopters. This element consists of a new idea, an individual who knows about the idea and those individuals who do not know about the innovation yet. The relationships (interactions) between those who know and those who do not know have a great role in spreading the idea. (3) A social system element defined as population of individuals who are functionally differentiated and engaged in collective problem solving behaviour. All of the members cooperate at least to the extent of having some common problems which

they are seeking to solve. Rogers (1968) explains that in social systems, there is a continuum of types of adoption decisions that ranges from individual to group decision. Most of the innovation is by individual decisions. However, at intermediate point on the continuum from individual choice to group decision is the type innovation requiring prior acceptance by the majority of the social systems' members in making decision of technologies adoption. That is, an individual may wish to adopt an innovation but he/she cannot do so until others join or accept the idea. Some ideas are adopted by a group decision that forces the acceptance, even upon those who are unwilling. Once the community decision is made, the individual has little choice. In some cases individuals with the influence in the social system are professional persons representing organizations external to the system, referred as change agents. (4) Adoption element of analysis refers to decisions to continue use of innovation, implying that the adopter is satisfied with the innovation.

Rogers elaborates on innovation adoption as a process that involves both learning and decision making, and which undergoes fives stages; awareness, interest, evaluation, trial and adoption. Mbogo (1987) concurs with the view that awareness is created for trial and adoption of technology through the provision of extension services that enable farmers to improve their dairy farming management and adopt high levels of breeding dairy cows. Mugivane (1999) supports the view further that the adoption of farming technology can be described as a behaviour that occurs in three ways: (1) Adoption behaviour as willingness to change and try new ideas. (2) Farmers focus in increasing profit. (3) Adoption of technological innovations as a consequence of change toward farming. Chitere (1994) describes the extension officers as professionals' change agents who bring about change, and who act as encouragers or enablers, guides, advisers or consultants who facilitate the process of change. Rogers (1968) argues that the adopters of the innovations are vehicles of technological transfer in the spread of technologies. However the characteristics of innovation / technologies do matter. The technologies that are simple are more rapidly adopted than those that are complex. Those that are easily and quickly adopted tend to be those whose relative advantage is immediate, obvious and a source of clear gain to the adopter. According to Rogers (1968), readily adopted innovations are also compatible with existing values and past experiences.

This study explains the factors affecting adoption of dairy farming technologies and the pattern of adoption among small dairy holders. Smallholder dairy farmers adopt the farming technologies because they believe that their dairy cattle productivity will increase and hence increase in the earnings. Farmers become aware of new farming technologies that will increase productivities, seek more information on technology, try it and adopt fully in farming to maximize benefits. Wattiux (1969) also holds this view that farmers who adopt a technology such as AI service in their dairy cows incur less cost while the resulting cumulative benefits of having high valued cows with great potential of milk production are huge. The adoption of dairy farming technologies such as AI, animal health care and giving the dairy cattle the right nutrition by the people of Githunguri carry the notion that people can improve their social life and gain financially.

Small dairy farmers as groups cooperate with the aim of solving problems facing them in dairy industry, such as searching of market for milk, sourcing for extension services, clinical services and AI services. Although an individual farmer may wish to adopt an idea aimed at improving his performance such as putting up of a milk cooling plant, he/she may be constrained by resources and unable to implement. Hence other farmers must accept, join and support his/her idea for it to be adopted and be implemented. Formation of dairy cooperatives in Githunguri not only provide the dairy farmers with marketing of milk, veterinary services and financial support, but also provide jobs among the local people and livelihoods for many more people.

The adoption of dairy farming technology is a process; and milk production determines the continuation use or full adoption of the technology by the smallholders. For instance, the farmer may decide to upgrade his indigenous breed by crossing with an exotic breed, and if unsatisfied with the production, then will keep exotic breeds. This attracts other farmers who may enquire and decide to do the same hence the technology spreads or diffuses among the small dairy holders. The theory helps to understand how farm technologies are adopted.

2.7.2 Exchange Theory

Social exchange theory began with roots in behaviourism in psychological and sociological perspectives that explain social change. The behavioural sociologists are

concerned with the relationship between effects of actors' behaviour on the environment and their impact on the actors' later behaviour positively, neutrally or negatively (Blau, 1964). According to Karl Marx, social exchange, together with value, use of value (utility) and price are the four attributes of a commodity. Marx indicates that the exchange value of a commodity is not identical to its price but represents what quantity of the commodities will be exchanged if traded.

According to Homans (1961), social exchange theory envisages social behaviour as an exchange of activity tangible or intangible and more or less reward or costly between at least two persons. The cost is incurred in engagement (actions) and the reward is what the person gets. He urges that if the action that brings more reward (success), the person is more likely to perform that action. If the response is positive, actors are more likely to repeat the behaviour, and when the response is negative they will be less likely to repeat the behaviour. People modify their behaviours in an attempt to maximize positive reactions and minimize negative reactions. Donna Garske (1991) believes that for social change to occur, a community must possess certain characteristics. These include, knowledge of an issue, changing attitudes about the issue, beliefs forming the issue and developing behaviours to deal with issue.

Blau (1964) views the social exchange explicitly from an economic framework, that the social interaction has value to the people. He emphasises action value and actions work effectively for actors seeking to achieve interests or social change. He argues that the provision of something from one person to person, when accepted by another, creates an obligation to reciprocate with provision of something of high value. Blau, (1964) contends that people are attached to each other for a variety of reasons that induce them to establish social associations. The associations remain strongly bonded if they provide rewards, and weaken if the reward is not insufficient. Reward could be income, physical labour, respect and many more.

The adoption of dairy farming technology is a behaviour that has both psychological and sociological dimensions. Farmers as actors of this behaviour change attitudes and embrace new technology in attempts to improve their livelihood through increased farm productivity. The behaviour (adoption of dairy farming technology) engagement incurs

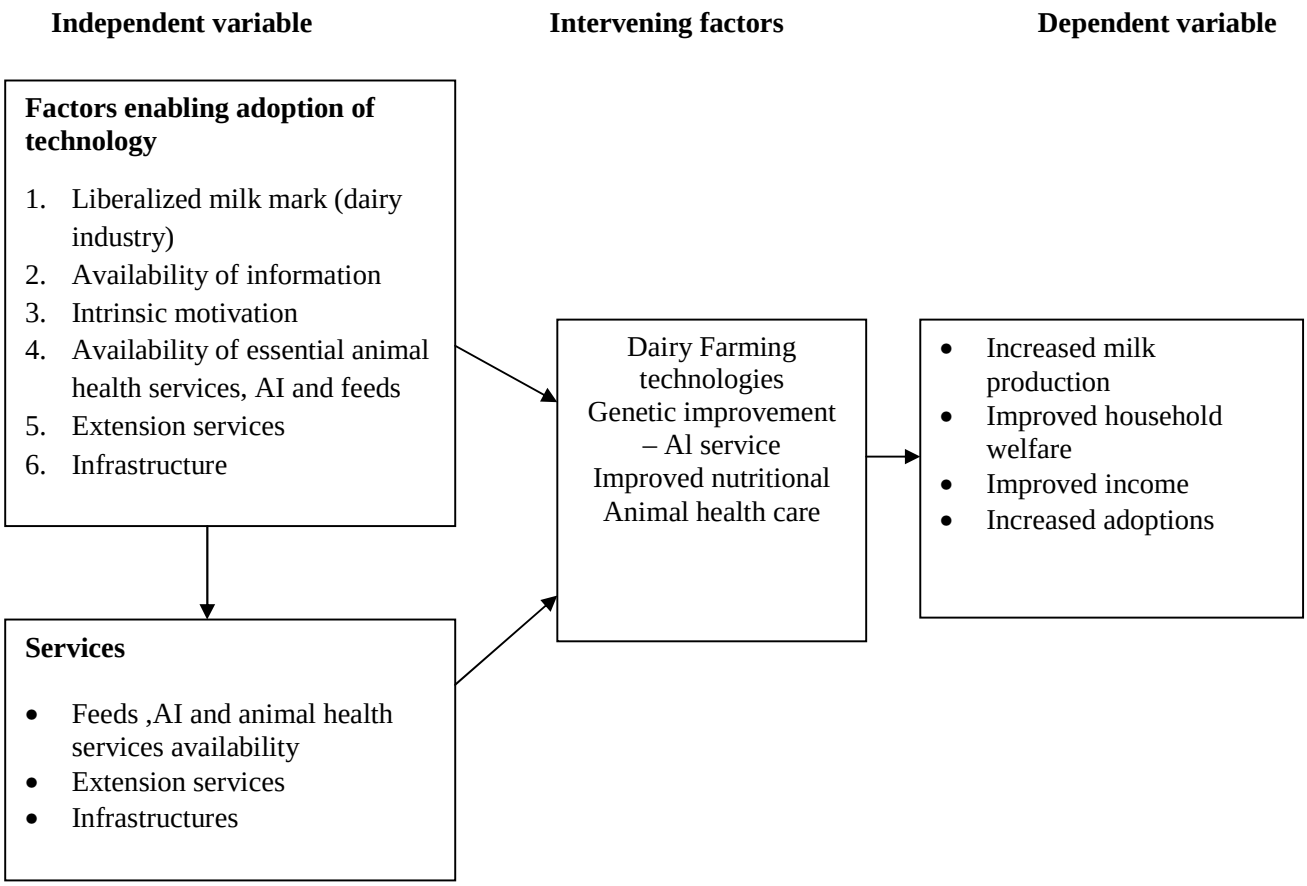
variation cost, and the reward consequences could have positive, neutral or negative impacts. Baltenweck, (2000) notes that dairy farming is a practice that involves high capital in acquiring and maintaining dairy cattle for optimal or maximum production. However, Stoz (1980) argues that farmers bear short term costs in investing in dairy technologies for resulting in ambiguous long and beneficial productivity. According to Mugiv,ane (1999), previous traditional communal practices such as community grazing and use natural method in breeding, must change to be compatible with dairy farming practices (that the farmer become aware of the need of technology). Donna Garske (1991), indicates that it is personal and socio-economic characteristics such as formal education, awareness, and experience in farming, affordability and suitability that influence the adoption of dairy farming technology. Chamberlin (1997) argues that, it is the individual farmer who must decide to adopt a new technology for his/her own operation and that the village is the basic work unit for change agents.

Formation of group associations such as farmers' cooperatives greatly enhance utilization of individual resources for better gain and power bargaining that influence the price to pay. Exchange theory assumes that people have access to information on interactions that they consider for alternatives or, for more profitable situations, relative to their present conditions. However, adoption of technology in developing countries is slow, restricted by various resource constraints and limited search for information (Philips, 1989).Farm technologies are introduced by one party and adopted by another .Therefore this theory helps explain the exchange relationship between those who introduce the technology and the adoptors.

2.8 Conceptual Model

The model shows the technologies adopted by small dairy farmers in attempts to increase cattle productivity, and factors affecting the adoption of dairy farming technologies. The enabling and impeding factors interrelate with each other during the adoption. Increased adoption translates to four things: increased milk production, improved household welfare, increased income and possibility of farther adoption.

Figure 1: Conceptual Model



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter captures the methodology that was used to conduct the research. It is organized under the following headings: site selection, description, research design, unit of analysis, unit of observation, sample design, methods of data collection, tools for data collection and data analysis

3.2 Site Description

The area selected for this study was Githunguri Division of Kiambu County, located in Central Kenya. Kiambu County borders Murang'a County to the North and North East, Machakos to the East, Nairobi and Kajiado counties to the south, Nakuru County to the West and Nyandarua County to the North West.

Kiambu used to be an administrative district of the then Central Province with a total area of 2543.4 Km^2 and a population of 744, 010.The county's dense population is an indicator of its potential in terms of large labour force. It is predominantly rural, but the influx of its urban population is increasing due to the close proximity and rapid growth of Nairobi centre. Kiambu County has five administrative divisions, namely Githunguri, Lari, Limuru, Kiambaa and Kikuyu. Kiambu County has attractive climate and landscape with temperatures that range from a minimum of $12.8c^0$ to a maximum of $24.6c^0$ with an average of $18.7c^0$. The average rainfall is 989 mm per annum. The county is surrounded by hilly farmlands, which are suitable for agricultural production. The rich highland soils, coupled with very favourable climatic conditions, have ensured that agriculture remains an integral part of the county's economy. Agriculture activities provide incomes for many households.

Roads network and communication are good, enabling easy movement of inputs such as animal feeds, agricultural chemicals and fertilizers. There is also easy provision of

essential services such as health, veterinary and extension, as well as enhanced delivery of milk to the processors and consumers.

3.3 Site Selection

Githunguri was purposively selected because of its unique characteristics of dairy farming. The division has established intensive dairy farming practice by small-scale farmers. Dairy farming in the division is a commercial activity that generates incomes, wealth creation and provides milk for households' consumption. The dairy cattle population is estimated at 46850 (GOK, 2009).

3.4 Research Design

The study adopted a descriptive research design. According to Mugenda and Mugenda (2003), a descriptive research design is the most appropriate where the problem at hand is well defined and where there is need to provide further insight into the research problem. The study used a descriptive design because it enables in-depth collection of the information; it describes, explores and summarizes the data in distribution measurements such as frequencies, tables and percentages that compress and make it easier to understand the data. According to Cooper and Schindler (2000), descriptive statistics discover and measure cause and effect relationships among the variables.

The research scope covered the small scale dairy farmers of Githunguri Division in Kiambu County on the adopted dairy farming technologies. The dependent variables include: (1) adoption of dairy farming technology whereas adoption is an output of what farmers do after awareness, interest, evaluation and trial of technology; measured in terms use of AI dairy cattle, numbers of dairy cattle per household, hectares of fodder and keeping of health records. (2) Productivity – the efficiency measures of this variable include milk output both sold and consumed in the household and dairy breed cattle owned. (3) Animal husbandry – this is the careful management of the dairy animals which include records keeping, animal health care, established fodder and good housing for the animals.

3.5 Unit for Analysis

The unit for analysis is the entity around which the researcher seeks to make generalizations (Singleton, 1988). It is what the study seeks to understand. Unit of analysis can be people, social roles, positions and relationships. The unit analysis for this study was the dairy farm unit.

3.6 Unit for Observation

The unit of observation refers to the source of the primary data from the respondents, about the issues under investigation. The study respondents were the small scale dairy farmers of Githunguri Division. The unit of observation included the interactions of the researcher with small scales dairy farmers who had adopted the dairy farming technology.

3.7 Sampling

Babbie (1995) indicates that sampling is unavoidable in any kind of scientific observation since the researcher wants to comment on broader patterns than he can hope to observe directly. A researcher should take as big a sample as possible, as with a larger sample the researcher is confident that if other samples of the same size were to be selected, findings would be similar to a high degree. According to Singleton (1988), a sampling design is that part of the research plan that indicates how cases are to be selected for observation.

There are two types of sample designs namely probability and non-probability. Babbie (1995) observes that probability sampling involves random selection. This means each element in the population has an equal chance of being selected. This study adopted both types of sample design. The population for this study is the total population of Githunguri Division in Kiambu County. The researcher in this study purposively selected Githunguri Division.

The study selected ninety-eight smallholder dairy farmers for the study, in such a way that the individuals represent the target population (smallholders' dairy farmers in Githunguri). The study identified a research population that would provide all the

information necessary in answering the research questions. The goal was to find out true facts of the sample that would also be the true reflection of the population. Multistage clusters sampling was utilized to get the final sample of household heads. The population was broken down into groups called clusters, which include locations, sub-locations and villages. This allowed computation accuracy of selection and a high degree of representatives of all the clusters irrespective of their size. In the first stage two locations were purposively picked, one that is more developed in terms of dairy farming and one that is less developed. These are Githunguri, which is intensively involved in dairy farming and Karatina, which is behind in dairy farming. The two form the first cluster. The sub-locations of the two locations were listed down and they are two sub-locations in Githunguri (Gathangari and Githunguri) and four sub locations in Karatina (Gathungu, Karatina, Kibichio and Thuita). In the second stage, one sub-location was picked using lottery sampling from each of the locations selected in the first stage. These are Githunguri and Kibichio; and they form the second cluster. These sub-locations comprises of several villages. In the third stage, the sample was divided among the sub-locations where five villages purposively selected from each sub-location. This makes a total of ten villages (third cluster) where ten household heads were systematically selected. A total of ninety-eight household heads were selected as the sample size for the study.

Table 4: Sampling Design

Division	First stage of clusters (locations)	Second stage of clusters (sub locations)	Third stage of clusters (number villages selected from sub locations)	Household heads village
Githunguri	Githaga			
	Githunguri	Githunguri	5	49
	Ikinu			
	Ngemwa			
	Karatina	Kibichio	5	49
				Total household heads=98

3.7.1 Sampling Frame

Sampling frame is an objective list of the population from which the researcher can make a selection (Denscombe, 1988). The degree of generalization of the study depends on the accuracy of the sampling frame from which the sample is selected (Mugenda, 2003). In this study sampling frame is the small-scale dairy farmers in Githunguri Division.

3.8 Methods of Data Collection

The researcher used both primary and secondary sources of data. Primary data was collected at the source and used for the study. Secondary source of data was used for analysis of the relationships between different variables and was sought from the available sources that include books, government publications, farming and sociological journals, newspapers, livestock breeders and milk processors magazines.

The process of data collection took place in Githunguri Division of Kiambu County and involved; locating and selecting the research community, selecting of sample units, and questionnaire design and field operations of data collection**.**

The study incorporated both quantitative and qualitative methods in data collection / gatherings. The two approaches produce results that are easy to summarize, compare, generalize and allow reliable information from numerical measurement backed by enriched information about the participants' explanations. Quantitative methods focused on numbers, frequencies that provide information which is easy to analyze statistically, whereas the qualitative methods describe and capture participants' meanings and interpretations. This provides more in-depth and rich description. The methods include interviews, questionnaire, observations, focus group discussion and key informants.

3.8.1 Interviews

The study used structured interviews, where the researcher asked each respondent the same question**.** Face-to-face interviews were carried out and respondents purposively sampled. The researcher used a questionnaire with closed and open ended questions.

3.8.2 Observation

The researcher used observation method to verify some of the data collected from the respondents. Direct observations used in areas such determining size of the land, presence of dairy cattle, fodder grown in the farm, feed storage, water reservoir and household structure. This method was used in order to reduce the chances of incorrect data being recorded.

3.8.3 Key Informant interviews

A key informant was anyone who could provide detailed information and opinion base on his or her knowledge of adoption of dairy farming technology in the study area. The study interviewed six key informants who are involved in dairy farming technology in the divisions and those in leadership of the area. Key informants included; the District Veterinary Officer, inseminator of the area / artificial service provider, veterinary doctor local agricultural officer, animal nutritionist, and factory dairy process manager.

3.8.4 Survey

Household survey of dairy farmers' interview took place of at the household

3.9 Tools of Data Collection

Tools refer to the instruments used data gathering. The study used questionnaires, key informants guide, and observation guide as tools for data collection.

3.9.1Questionnaire

The study used questionnaire as the main tool of data collection. The structured questionnaire was prepared before embarking on the field work and divided in various sections based on specific objectives, literature review and problem statements. Questionnaires were identical to allow for comparison of answers and hence facilitate the computation of summary statistics. The questionnaires were administered by the researcher and research assistants to small dairy farmers of different ages, gender,

religion and literacy who kept dairy cattle. The respondents of the study were the household heads.

The questions were clear and related to adoption of dairy farming technology concept; and gave the directions to the respondents, and included both closed-ended questions and open-ended questions. This yielded primary data collected for statistical analysis of this study.

3.9.2 Observation Guide

The observation guide identified what the researcher was looking for. The researcher observed the presence, breed of dairy, farming types, land size, fodder stored and growing in the field, water reservoirs, check animal health and reproductive records and household.

3.9.3 Key Informant Guide

A key informant guide was used to generate information for the study. The researcher developed an interview guide beforehand to ensure that areas of study interest are well covered**.** Open-ended questions were used to ensure extensive gathering of information.

3.10 Data Analysis

Once data was collected, it was coded and analyzed using SPSS. It was presented in form of table presentations. Descriptive statistic approach was used to analyze the data. This includes the use of tables, frequencies distribution and percentages. This helped critically in checking of the data transformation, data modeling, information summary, suggesting of conclusions and decisions making in the study.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF RESULTS

4.0 Introduction

This chapter comprises background information which describes the socio-economic variables of the respondents. Variables addressed include formal education, family size, age, marital status, gender, religion land size. The chapter also presents information on genetic improvement through use of AI, breed of dairy cattle kept, feeding management, animal health care and constraints farmers experience in rearing cattle in dairy farming technologies adoption.

4.1 Descriptions of the Respondents

This section describes the characteristics of the respondents. These include age distribution, gender, marital status, formal education, religion, land size and family size.

4.1.1 Age

Table 5: Age Distribution

Age	**Frequency**	**Percentage**
21 - 35	28	28.6
36 - 50	22	22.4
51 - 65	30	30.6
>65	18	18.4
TOTAL	**98**	**100**

The age distributions of respondents are shown in the Table 2 above, 28.6% were in the range brackets of 21-35 years, while 22.4% were in the range brackets of 36-50 years old. Most of respondents were in the age distribution of 51-65 years old .The respondents with over 65 years of age and considered old were 18.4%.

4.1.2 Gender

The gender distribution of household, 48% of respondents were male and 52% of respondents were female. This showed both gender were available for the interview. According to the GOK census (2009) the males in Kiambu County constitute of 49.4% while female constitute 50.6% of the gender in the county.

4.1.3 Marital Status

Majority of the respondents (90.8%) indicated that they were married, while 7% were single and only 2% of the respondents were separated.

4.1.4 Formal Education

Majority of the respondents had some formal education. Table 3 below shows that respondents educated to secondary level comprise 44.9%, and 33.7% having been educated to primary level, 16.3% post-secondary education and 5.1% grouped as illiterate.

Table *6*: Education Level of Respondents

Education Level	**Frequency**	**Percentage**
Illiterate	5	5.1
Primary Level	33	33.7
Secondary Level	44	44.9
Post Secondary Level	16	16.3
TOTAL	**98**	**100**

4.1.5 Religion

The sample population was dominated by Christians. However, seven of the respondents did not indicate their religion affiliations. The denominations distribution of the respondents is that 41.8% were Protestants, 28.6% were Catholics while 17.6 % and 11.0% are Anglicans and Methodists respectively.

4.1.6 Family Land Size

Most of the respondents indicated that they have less than one acre of land, a majority of whom acquired the same through inheritance. On family land size, 55.1% of the respondents indicated that they have less than one acre of land while 33.7% indicated have one to three acres of the land. Those who have three to five acres comprise 5.1% while those with over five acres of land comprises 6.1 %. Therefore land sizes are small and ideal for zero grazing.

4.1.7 Family Size

Regarding the question on the family size, ninety-three of the respondents indicated their family size while five did not respond. Majority of the respondents, comprising 45.2%, indicated that they have household size of seven plus, while 30.1% indicated five as average household size. The researcher noted this group to be over 35 years old. At least 24.7% of the respondents have family size of between one to three, a majority of them below 35 years old. According to the GOK (2009), the household average size of the study area is four.

4.2 Patterns of Dairy Farming Technologies Adoption

The study sought to assess how the dairy farming technologies have been adopted by the small scale dairy farmers in Githunguri and the effect on milk production. The researcher concentrated on three areas of technologies namely: genetic improvement on the dairy breeds of cattle through use of AI, improvement on feeding and animal healthcare.

4.2.1 Genetic Improvement

The genetic improvement was categorized into two areas namely: dairy breeds that the farmers keep, and use of AI in upgrading the existing herd.

4.2.1.1Breed that Dairy Cattle Farmers Keep

Several types of dairy breed cattle have been genetically developed to produce great quantities of milk to meet demand for household consumption and commercial purposes in the world. The study sought to assess types of dairy breeds farmers keep for milk production and how they acquired them. Baltenweck (1991) indicates that farmers can

acquire high dairy producing cattle through buying or improving the existing herd. According to the GOK (2009), there is an estimated dairy cattle population 46, 850 in Githunguri Division acquired through these means.

The majority of the respondents indicated that they keep Friesian breed of cattle. This is because Friesian breed of cattle produces more milk than any other breeds in the area. A key informant (animal nutritionist) stated that "well-kept Friesian cow produce more than 25 litres of milk per day." According to Table 4 below, 68.4% of the respondents keep the Friesian breed of cattle, followed by 13% who keep both Friesian and Aryshire breed of cattle. Therefore the productivity of technology influences the adoption. This is because Friesian cattle, which produces more milk, and is therefore more beneficial to the farmers, is more easily adopted than those that produce less milk, even though preferred by local consumers.

Both Friesian and Aryshire are high producers, however Aryshire compared to Friesian is less productive in terms of milk production but her milk has more solidity, hence the quality of milk in the farm is improved. At least 11.2% respondents keep Aryshire breed cattle while 4.1% have cross dairy breeds of cattle. The cross breeds of cattle have traits that resist diseases better than pure breeds. Therefore the cost of animal health care is reduced. Although Aryshire breeds produce less milk compared to Friesian, farmers keep them because their milk has more solidity and is preferred by most local consumers in the area. It is also liked more because it is the most available as most of Friesian milk is sold to processing dairies and therefore not available to local consumers. This shows that farmers are market oriented since the quality and high production enable them to sell the milk. From the data collected, 3.1 % of the respondents indicated that they keep Guernsey, a breed smaller in size compared to both Fresian and Aryshire hence less feed is required. The solid milk contents of Guernsey are higher and therefore easy to sell to local consumers.

Table 7: Breed of Cattle

Breed	**Frequency**	**Percentage**
Friesian	67	68.3
Aryshire	11	11.2
Friesian &Aryshire	13	13.3
Cross dairy breeds cattle	4	4.1
Guernsey	3	3.1
Indigenous	0	0
Total	**98**	**100**

4.2.1.2 Use of AI in the Dairy Breed

The study sought to assess to the acceptability of AI as technology of genetic improvement of the dairy breeds. The study revealed great awareness and usage of AI. All the 98 respondents indicated they use the AI in their dairy breeds for various reasons. AI gives the farmers an opportunity to select the sires that transmit desirable traits in the dairy cattle and eliminate the cost and danger of keeping a bull. It minimizes transmissions of STDs. A key informant (inseminator) practicing in the area of study commented as follows: *The AI technology has been well taken by the small scale farmers and uses mainly local semen straws.*"

Although all respondents indicated they use AI, about 66.4% showed that they have used AI in less than 10 years. According to the data collected as shown in Table 6 below, 33.7% of the respondents have used AI on their dairy cattle in less than 5 years while 32.7% of the respondents have used AI for period between 5 to 10 years, 17.3% over 20 years and 16.3% in period between 10 to 20 years. This shows that adoption of the dairy farming is a process and farmers' satisfaction determines the continuity of its use. The duration of AI by the respondents is shown in the Table 5 below.

Table 8: Duration of using AI

Duration in Years	**Frequency**	**Percentage**
Less than 5	33	33.7
5 to 10	32	32.7
10 to 20	16	16.3
Over 20	17	17.3
Total	**98**	**100**

4.2.1.3 Why use AI in Dairy Cattle

From the responses obtained, 42.8% of the respondents, who have adopted AI, indicated that AI is safe in their dairy cattle while 32.7% of the respondents have adopted expecting to get heifers that are genetically developed to produce more milk in future, 18.4% indicated high conceptability as there as on for adoption AI technology. As indicated in literature review, Wattiux (1996) argues that cattle served through AI have low incidences of difficult in calving and low chances of getting STDs. Although AI is considered cheap only 6.1% of respondents indicated it as cheap. A key informant comment as follows: *"The cost of inseminating a with local straw semen is about KSh 700 while the imported straws range from KSh 1, 200 to KSh 7,000"*. Most of the respondents use the local straw which is cheap, showing that the cost of technology affects adoption of technology. Technologies that are cheaper and affordable are more easily adopted. Baltenweck (1991) indicates that small dairy farmers who cannot afford to buy high producer dairy cattle can still get high producers cattle through genetic improvement.

To determine the strengths of adoption, the study enquired from the respondents whether they would recommend others to adopt the AI technology in their dairy cattle. A total of 96 respondents indicated that they would recommend the same to their neighbours. A majority of the respondents comprising 98% indicated that they would recommend and 2% did not respond. The AI technology was recommended as safe by 50% of the respondents, while 24.5% recommended it as technology with high conceptability.

21.4% of the respondents would recommend to other farmers as expected heifers would be high producers. The researcher found that farmers envy calves born from AI technology, subsequently adopting the technology. This concurs with Rogers (1968), who suggests that the adopters of the innovations are the vehicles of technological transferring the spread of technologies.

According to the Table 6 below, 50% the respondents would recommend other farmers to use AI in the dairy herd because it is safe while, 21.9% would recommend it because AI has high conceptability. This shows safety of a technology determines its adoption. Technologies that are safe to use are easily adopted. According to Wattiux (1996), AI minimizes chances STDs hence the dairy cattle conception is high and the cattle carry the pregnancy to term. At least 21.9% of the respondents indicated that they would recommend AI because born heifers produce more milk enough for home consumption and commercial purposes, because cattle with superior genes of high milk production potential are utilized. Although AI is considered cheap, only 4.2% of the respondents would recommend use of AI because it is less costly. Muriuki (2001) argues that, this is one of the effects of liberalization of dairy industry in 1992, where farmers now incur the full cost of inseminating their cattle.

Table 9: Reason for Recommending Use of AI

Recommendation	**Frequency**	**Percentage**
Cheap	4	4.2
Safe	48	50
High Conceptability	21	21.9
Expected heifers or daughters are high producers	21	21.9
Total	**96**	**100**

4.2.1.4. Adoption of Dairy Farming Technologies and Socioeconomic Variables

This study also sought to assess the relationship of adoption and socioeconomic variables. According Lionberger (1982), farmers are influenced by socioeconomic variables in trying to reach family goals. Bahemuka (1985) found that formal education, family size, age distribution and marital status are also important factors that could affect adoption of dairy farming new technologies.

4.2.1.4.1 Adoption of Technology and Formal Education

For the adoption of new technologies education is an important variable to be considered as it explains an individual's responsiveness to change. According to Dahama and Bhatnagar (1987), education is applied in behavioral science, the knowledge which is used to bring about desirable changes. Most of the respondents comprising 96.9% indicated that they have formal education. Therefore small holders in the study area embrace change of dairy farming. This implies also that extension education can be taught in one language. The study related formal education and the breed of cattle respondents keep. Friesian breed of cattle was used in this relation as it is the highest producer among the breeds in this study. Out of 98 respondents, 68.4% keep Friesian as shown in the Table 7 below.

Table 10: Adoption of Friesian Cattle and Formal Education

Formal education	**Frequency**	**Number of respondents who keep Friesian cattle**	**percentage**
Illiterate	5	3	4.5
Primary level	33	24	35.8
Secondary level	44	32	47.8
Post secondary level	16	8	11.9
Total	**98**	**67**	**100**

According to the table above, 35.8% of the respondent had primary education, while 47.8% had secondary education. They all keep Friesian breed of cattle. This implies that education is important for adoption of technology. Those people who are educated positively respond to technology. Although only 11.9 % of with post secondary education keep Friesian, the total respondents with post-secondary is low comprising of 15.3% of the respondents. Only 4.5% illiterate respondents keep Friesian breed. This suggests that even those with no education will emulate the adopted technology from the educated ones.

4.2.1.4.2. Age and Adoption

Age was considered as an important variable as it is known to positively influence the acceptance of dairy farming technologies. The prior theory is that the young farmers have high propensity to change than old ones. The old ones tend to be conservative in accepting farming technologies. According to the data collected, 49% of the respondents are below 50 years old. This may be considered the ripe age for adoption of technology in dairy farming. About 27.6% of the respondents are below 35 years old. This implies that young people are involved in dairy farming, showing further that lack of white collar jobs had led young people to go back to rural areas and farm in small family plots. According to Table 8 below, 95.5% respondents in the age between 36-50 years old supplement their cattle with feed concentrates and mineral salts while 92.9% of the respondents in the age between 21-35 years supplement their cattle with feed concentrates. From the data, 86.7% of respondents in the age 51-65 supplement their cattle with concentrates while 77.8% over 65 years supplement their dairy cattle with feed concentrates.

Table 11: Age and Adoption of feed Concentrates and Mineral Salts

Age in Years	Frequency	Numbers of those who supplement their cattle with feed concentrates and mineral salts	Percentages
21-35	28	26	92.9
36-50	22	21	95.5
51-65	30	26	86.7
>65	18	14	77.8

4.2.1.4.3 Gender and Adoption

Gender roles and responsibilities in term of content and context have important implications for men and women status in the society. This is partly because gender is a phenomenon that is socially constructed and leads to assigning roles for men and women. Culturally, gender characteristics defined and stereotyped men and women in an attempt to perpetuate beliefs and norms that a society may deem necessary for its survival. Based on the data collected, 48% of respondents were male while females comprise 52%. However, most females filled the questionnaire on behalf of husbands who were not at home at the time of dropping the questionnaires. The researcher noted that both females and males participate in nearly all activities of the dairy farming. However, men are the heads of the family; they make the final decisions especially on the disposal of cattle and buying new ones. They also receive milk payments and make decisions on money distribution.

4.2.1.4.4 Adoption and Marital Status

As a socio-economic variable, marital status is often associated with influences in decision making. This is because married couples are considered to belong to stable families which offer support in decision making and adoption of new ideas. Based on the data collected, 90.8% of the respondents are married. Although dairy farming in the study area is commercial activity, majority of the husbands are employed elsewhere, leaving the dairy farming management to their wives. However, the researcher observed couples working together in the dairy units.

4.3 Feeding Management

4.3.1 Fodder Establishments

The establishments of fodders are clear indicators that farmers are ready to do dairy farming. A well-fed animal grows faster, produces more milk and remains in a good health status. Technically one dairy cattle requires one-and–three-quarter of an acre of fodder. However, on the basis of collected data, most of the fodder grown is not enough to feed the dairy cattle and farmers hence incur costs of buying extra feeds. Fodder grown is also subjected to seasonality, with most farmers growing during the rainy season. The researcher noted that most of respondents have small land size of less than an acre comprising of homestead and fodder. The main types of fodder grown in the area include Napier grass, Rhodes grass, Lucerne and maize stalks. Napier grass is a major fodder grown in the study area because climatic condition of high rainfall allow for its growth all throughout the year. Napier grass is an improved fodder grass that produces a lot of high protein forage that is required by the dairy cattle. Therefore fodder with high nutritive value is more adopted than fodder with less nutritive value. Most of the respondents, comprising 54.1%, indicated that they have less than an acre for growing fodder. According to Njarui *et al* (2009), case study on feeding management of dairy cattle cited inadequate nutrition as a major constraint that negatively affects the growth and viability of dairy farming. The study established that farmers feed their cattle on fodder, concentrates, and mineral salts below the recommended requirements. The study analyzed the types of feed used, source of feed and the fodder land size.

4.3.1.1 Types of Feed Used

Table 9 below shows the type of feeds the respondents give to their cattle.

Table 12: Types of Feed Used

Type of Feed Used	Frequency	Percentage
Fodder	4	4.1
Fodder & concentrates	7	7.1
Fodder, concentrates and mineral salts	87	88.8
Total	**98**	**100**

According to Table 9 above, 88.8% of the respondents indicated that they feed their cattle on fodder, concentrates and mineral salts while 7.1% feed their cattle on fodder on concentrates. This implies that small dairy holders are aware of feed requirements of the cattle and are willing to feed their cattle for the purpose of getting high milk production for home consumption and commercial purposes. The respondents who feed their cattle on fodder alone comprise 4.1%.

4.3.1.2 Sources of Fodder

Reynolds *et al* (1999) showed that smallholder farmers produce about 70% of the feed from their own resources. This study also sought to assess small dairy holder fodder source. The responses are indicated in the Table 10 below.

Table 13: Source of fodder

Sources of Fodder	Frequency	Percentage
Own farm	39	39.8
Own farm & Buying	49	50.0
Buying	10	10.2
Total	**98**	**100**

According to Table 10 above, 50% of the respondents grow and buy fodder for their cattle while 10% buy fodder for their cattle. This shows that although land is a major challenge, smallholders dairy farmers are willing to feed their cattle for the purpose of milk production. Most of the respondents buy the fodder from the neighbors or the people within who grow fodder for commercial purposes, implying that even those who do not

have cows also economically benefit. At least 39.8% of the respondents indicated they grow fodder for their cattle.

4.3.1.3 Fodder Land Size

The study also sought to assess the size of land occupied by the fodder. Table 11 below shows the responses on fodder land size.

Table 14: Fodder Land Size

Fodder land size	Frequency	Percentage
<1 acre	53	54.1
1 to 3 acres	32	32.7
3 to 5 acres	5	5.1
> 5acres	8	8.1
Total	**98**	**100**

According to Table 11 above, 54.1% of the respondents indicated that their fodder land size is less than one acre while 32.7% indicated that their fodder land size is about one to three acres. The small land size is as a result of sub-divisions of land into small plots due to increased population pressure which poses a big risk to dairy farming. Those respondents who have three to five acres of fodder comprises 5.1% of the respondents while 8.1% indicated their fodder land size is five acres.

4.3.2 Feed Concentrates and Mineral Salts

The concentrates are commercial feeds used as additional supplements in enhancing milk production and faster growth in young ones. They are important in correcting certain deficiencies in forages and low feed (fodder) intake. The commonly used concentrates are dairy meal, maize germ, pollard and bran. The prices of the feed concentrates have been fluctuating due to factors such as availability of raw materials and transport cost. However, a bag 70 Kg dairy meal on average costs KSh 1, 600; a bag 70 Kg pollard costs KSh 1, 400 while a bag of maize germ costs KSh 900. Feed concentrates increase milk production and lead to increased sales of the milk and therefore rising household incomes. The farmers buy the feed concentrates from the nearby agro-vets and also from some shops. Dairy meal concentrate is most preferred because it contains more nutrients

compared to other concentrates. It is also fed to dairy cattle depending on the amount of milk produced by each cow. According to Gachuiri (1998), feed concentrates should constitute 40% of the dry matter fed to the dairy cattle. However, most farmers feed their cattle below the requirement, citing high cost of feed concentrates.

Mineral salts are elements added to animal feeds grouped into macro elements and micro elements. Macro elements are essential and required by dairy cattle in large amounts. They include calcium and magnesium. Micro elements are essential and required in small amounts and include cobalt, iron and manganese. Mineral salts increase and improve the quality of milk. They also play a big role in reproductive activities of dairy cattle as they induce heat, enhance conception and maintain pregnancy. A dairy cow requires 100g of well constituted mineral salts for it to maintain body condition and there after 60g for every five litres of milk produced. Smallholders add mineral salts to their cattle feed to improve livestock productivity. Therefore, a technology that enhances productivity is adopted to improve performance. Mineral salts are only in the market. Therefore, the only product in market is more easily is adopted.

The researcher observed all the shopping centers have livestock feed stores. This indicates that farmers buy concentrates for their dairy cattle and also incur less cost in transporting feeds to the farm. The major form of transport used by farmers is motor bikes. The researcher noted most farmers use maize germ rather than more expensive dairy meal whose quality was known to be variable, even though is considered more nutritive. Therefore feed concentrates with more and high quality is adopted than those without.

The study noted great awareness in feeding the cattle with concentrates in addition to fodder. From the data, 95.9% of respondents supplement their cattle with concentrates. On the question of where they use the concentrates in addition to fodder, 78.7% of respondents indicated that the concentrates increase milk production while 11.7% of the respondents indicated that concentrates enhance growth of young ones and increase milk production. At least 4% indicated that concentrates increase milk production and fattening their cattle. However, the researcher observed the cattle are given low amount of concentrates due to high cost of the feeds.

Table 15: Reasons for Using Commercial Concentrates

Reason for Commercial Concentrates	Frequency	Percentage
Increase milk production	74	78.7
Increase milk production and enhance growth of young ones	11	11.7
Enhance growth of young ones	1	1.1
Fattening	3	3.2
Increase milk production & Fattening	5	5.3
Total	**94**	**100**

4.3.3 Effects of Concentrates on Milk Production

According Gachuiri (1998), on dairy cattle nutrition, a good dairy cattle yielder produces 12 litres of milk per day on fodder alone. Thereafter an increment is as result of concentrates and minerals supplement. For every one of litre milk increment, one and half kilograms of dairy nutritive concentrates are required. Regarding the effects of concentrates on milk production, 71.3% of the respondents indicated that concentrates increase milk production greatly (over 5 litres) while 23.4% indicated milk production increases slightly (less than 3 litres). At least 5.3% of respondents indicated no change in milk production. This variation could be due to various factors such as quality and quantity of concentrates. According to a key informant, most of the farmers give less than recommended amounts of concentrates while some farmers cite the poor quality of the concentrates as reason for low production of milk in the dairy cattle. The responses of effects of concentrates on milk production are summarized in Table13 below.

Table 16: Effects of Concentrates on Milk Production

Milk production	Frequency	Percentage
Increase greatly (over 5 litres)	67	71.3
Increase slightly (less 3 litres)	22	23.4
No change	5	5.3
Total	**94**	**100**

Regarding the question of whether they would recommend other farmers to use the concentrates in addition to fodder, 96.9% of the respondents indicated that they would recommend while 3.1% would not. Recommendation on concentrates by the respondents are shown in Table 14 below.

Table 17: Recommendation of Concentrates by the Respondents

Recommendation	**Frequency**	**Percentage**
Recommend	95	96.9
Not recommend	3	3.1
Total	98	100

Out of the 96.9% recommending use of commercial concentrates, 84% indicated increase of milk production as reason for recommendation while14.9% indicate increase of milk production and enhances growth for the young ones as the reason for recommending use of concentrates. The reasons for recommending of commercial concentrates are captured in Table 15 below.

Table 18: Table 15: Reason for Recommending Commercial Concentrates to Other Farmers

Milk Production	**Frequency**	**Percentage**
Increase milk production	79	84.0
Increase milk production and Enhance growth	14	14.9
Enhance growth	2	2.1
Total	**95**	**100**

4.3.4 Feed Storage

Feed storage is necessary in ensuring that the dairy cattle have feed throughout the year, thus milk production and growth of the young ones is maintained. Hay and silage are the commonest forms of feed storage that most farmers use. Feed conservation either as hay or silage is important as it extends feed availability and quality for livestock during the period of scarcity. Farmers store feed/conserve feed to ensure that feed is available during dry season and therefore sustain the production of the dairy cattle. Therefore feed conservation for dairy cattle is an important strategy adopted by smallholder farmers to mitigate against feed scarcity.

Due to increase in population pressure, land has been divided into small plots and little is left for growing fodder for the animals. The study sought to assess the level of feed storage among farmers. According to the data collected, 57.1% of respondents do not store feed while 42.9% indicated that they store. Those who do not store feed, blame the small land size which limits fodder production. Among those who store feed, 50% indicated that store they hay while 28.6% indicated that they store hay and silage. At least 21% of the respondents indicated that they store silage. However, feed stored is not enough to feed cattle throughout the year. The feed stored hardly lasts for two months. The researcher observed that there are small land sizes for growing fodder owned by the farmers in the Githunguri Division and the fodder grown is directly harvested and fed to the cattle.

Table 19: Responses on Feed Storage

Feed storage	**Frequency**	**Percentage**
Yes	42	57.1
No	56	42.9
Total	**98**	**100**

Table 20: Types of Feed Stored

Types of Feed Stored	Frequency	Percentage
Hay	21	50
Hay and silage	12	28.6
Silage	9	21.4
Total	**42**	**100**

4.3.5 Challenges in Feeding Cattle

Inadequate nutrition is a major constraint that impacts negatively on the growth and viability of dairy farming (Njarui *et al*, 2009). On the question regarding the major challenges in cattle feeding, 54.1% of the respondents indicated high cost of feed while 23.5% indicated lack of fodder in feeding the cattle. This is attributed to pressure of increased population resulting to land subdivision into small plots, therefore inadequate fodder grown. The fodder grown hardly lasts for three months when harvested and hence farmers have to buy fodder elsewhere, hence extra cost and time consuming. This can also be explained by people competing with cattle for food and therefore the high cost of feed concentrates. A bag of 70 Kg of dairy meal costs an average of KSh1, 800. This is considered expensive by most smallholders and has been fluctuating upwards depending on availability of raw materials. Based on the data collected, 16.3% of the respondents indicated poor quality of feed as a major challenge in feeding cattle while 6.1% indicated high cost of labour in feeding cattle. Farmers complained of low milk production with some concentrates will others do not cause any change. Dairy farming is labour intensive. An average manual labourer per day in the study area earns about KSh 250. This is considered high and most farmers work extra hours to avoid this cost. The major challenges of feeding the cattle are in Table18 below.

Table 21: Major Challenges in Feeding Cattle

Challenge	Frequency	Percentage
High cost of feed	53	54.1
Lack of fodder	23	23.5
High cost of labor	6	6.1
Poor quality	16	16.3
Total	**98**	**100**

4.4 Accessibility to Animal Health Care

Provision of animal health services is an important aspect in dairy farming, as it prevents huge losses through reduced milk production, stunt growth of young or even death of dairy cattle. The activities involved in animal health include prevention, routine practices and curative measures. These are vaccinations, deworming, dipping and treatment of the sick ones. There are available animal health providers that farmers can access, including the Department of Veterinary Services, Ministry of Livestock, private veterinary doctors, animal health assistants and community animal health providers. Following the privatization of clinical services farmers now seek veterinary services from private practitioners while the government's role is limited to disease control.

Most of smallholders are able to report sick dairy cattle by observing the signs of the sick animals. The animal health record is a reference document showing the past health status of the dairy cattle. Animals that are always on treatment are costly to maintain and reduce the farmer's income and therefore culled for the purpose of cutting costs. Therefore keeping animal record is adopted as a technology that enables the farmer to keep healthy animals and reduce the cost of dairy farming. The study sought to assess the availability of animal health record keeping and animal health providers used. According to the data collected, 67.4% of the respondents indicated that they keep the animal health records

while 31.6% indicated that they do not keep animal health records. Table19 below summarizes the responses of animal health record keeping.

Table 22: **Health Record Keeping**

Animal Health Record Keeping	**Frequency**	**Percentage**
Yes	66	67.4
No	31	31.6
None response	1	1.0
Total	**98**	**100**

On the basis of the results obtained in the study, veterinary doctors were the most accessed animal health providers. This is attributed to the area's great potential of dairy farming that also attracts animal health providers. The veterinary doctors were preferred due to high competency in providing animal health services. Farmers in the study used both public and private animal health providers. There are good infrastructural facilities making them accessible to the farmers. In Githunguri Division there are government veterinary and livestock offices, private veterinary doctors and several animal health providers. Most of the private practitioners are located in shopping centers. Farmers also use veterinarians in Kiambu, about 20 Kms away, and in Ruiru about 15 Kms away.

The presence of many private animal health providers is an indication of high demand of veterinary and animal health services. However, majority of the respondents are not able to differentiate the clinical animal health providers. The researcher observed a number of agrovet shops operated by animal health providers, most of them being animal health assistants. The researcher also noted that a few farmers administer drugs by injection to their cattle after guessing the diagnosis. A majority of respondents, 69.4%, indicated that they used veterinary doctors as their animal health providers, while 25.5% indicated that they used animal health assistants as their animal health providers. At least 5% of the

respondents indicated that they used both veterinary doctors and animal health assistants. The animal health providers given are summarized in Table 20 below.

Table 23: Animal Health Providers

Animal Health Provider	**Frequency**	**Percentage**
Veterinary doctors	68	69.4
Animal health assistants	25	25.5
Animal health assistant and veterinary doctor	5	5.1
Total	**98**	**100**

4.4.1 Disease Control through Vaccinations

Vaccinations against major cattle diseases play a great role in minimizing huge losses through deaths of animals or lowered milk production in affected group of animals. The major diseases in the study area vaccinated against are FMD, vaccinated twice a year, Black quarter and Anthrax done once per year as well as LSD done once in every two years. The study sought to assess whether farmers do vaccinate their animals against various diseases. According to the Veterinary Department, there are vaccinations regime supposed to be followed. The researcher found that private animal health providers hardly organize for massive vaccinations, viewing it as a government role which has not been adhered to due to inadequate resources. According to the data collected, majority of respondents comprising 75.5% vaccinated their cattle twice a year, while14.3% indicated that they vaccinate at least once per year. Over 6% vaccinate yearly and during outbreaks of diseases. The frequency of vaccinations is summarized in the Table 21 below.

Table 24: Vaccinations Frequency

Frequency of the Vaccination	Frequency	Percentage
Twice a year	74	75.5
Yearly	18	18.4
Yearly and during outbreaks	6	6.1
Total	**98**	**100**

4.4.2 Helminthes Control

Helminthes are internal parasites that deprive animals of nutrients, thus causing stunted growth of the young ones and reduced milk production in lactating dairy cattle. The parasites therefore lead to reduced household incomes. The parasites include roundworms, hookworms and flukes. There are recommended deworming regimes, with most animal health providers recommending three months interval. Majority of farmers are able administer the dewormers to their cattle as most of them are administered orally. Therefore products that are available in the market and easy to administer are adopted more than those that are difficult administer. According to the data collected, all respondents indicated they deworm their cattle. Out of the total respondents, 45.9% indicated that they deworm cattle every three months while 41.8% indicated that they deworm every six months. At least 7% indicated that they deworm their cattle yearly, while 3.1% of the respondents indicated that they deworm when cattle show signs of infestations. Although the recommended regime is deworming every three months, this is great awareness and acceptance of technology. One of the drugs store keeper interviewed by the researcher indicated a high turnover of dewormers during rainy season. The frequency of cattle deworming is summarized in Table 22 below.

Table 25: Frequency of Deworming of Cattle

Frequency of Cattle Deworming	Frequency	Percentage
Every 3 months	45	45.9
Every 6 months	41	41.8
Once per year	7	7.1
When cattle show signs of worm infestation	3	3.1
No Response	2	2
Total	**98**	**100**

4.4.3 External Parasites

These are known to transmit diseases to the livestock which are expensive to treat or cause death of the animals. They also cause a lot of irritation to the dairy cattle. These external parasites include flies, ticks, tsetse flies and fleas. They are controlled mainly by spraying or dipping the animals. Most animal health providers recommend spraying or dipping of the dairy with acaricides, which should be done at least once per week to control the external parasites. The acaricides are available in the market and are easy to apply. Therefore a product that is market and easy to apply is adopted more than that which is difficult to apply. On the question of whether they spray or dip their animals against external parasites, 67.3% of the respondents indicated that they spray their cattle while 28.6% indicated that they do not spray their animals against external parasites. This fair acceptance of the technology is despite the danger the parasites have on the dairy animals.

A veterinary doctor practicing in the area commented as follows: "*There is high prevalence of tick borne diseases in the area especially rainy season*" The responses of spraying / dipping against the parasites are captured in table 23 below.

Table 26: Responses of Spraying / Dipping Against External Parasites

Spray / Dip Against External Parasites	**Frequency**	**Percentage**
Yes	66	67.3
No	28	28.6
None response	4	4.1
Total	**98**	**100**

4.4.4Challenges Farmers Face in Accessing Animal Healthcare

The study sought to assess the challenges farmers face in accessing animal healthcare. Before liberalization of dairy industry, the government used to provide the small farmers with free services or at very low fee. Privatization of clinical services in 1994, and implementation of the cost sale of veterinary drugs, meant the farmers incur the full cost of services. According to the data obtained, 71.4% of the respondents indicated that the services are costly, while 22.4% indicated unavailability of qualified animal health providers. Although the study area is rich in dairy farming, there is shortage of trained animal health providers in the area. From the responses, 3.1% of the respondents indicated costly and unavailability of animal health providers. This is a major challenge the farmer encounters in the dairy farming. One animal health provider concurs with farmers, citing the cost of drugs, professional service and related costs. The challenges of animal health care are captured in Table 24 below.

Table 27: Challenges of Accessing Animal Healthcare

Challenge	**Frequency**	**Percentage**
Costly	70	71.4
Unavailability of qualified animal health provider	22	22.4
Costly and unavailability of animal health provider	3	3.1
No Response	3	3.1
Total	**98**	**100**

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter summarizes the findings of the research project. It also draws conclusions on the research questions based on the findings from the study. Recommendations based on the research objectives and areas of further study are also pin-pointed.

5.1 Summary of Findings

The general objective of the study was to find out the determinants and social and economic effects of adoption of daily farming technologies among smallholders in Githunguri Division of Kiambu County. Specifically the study sought to find out smallholders receptability of new dairy farming technologies, types, nature and pattern of adopting dairy farming technologies. Based on this objective, the study concentrated on three areas on dairy farming technologies used by the small dairy farmers namely; genetic improvement of existing dairy herd through the use of AI, feed management and animal health care. Dairy farming is a major activity in the area of study, where a majority of the people derive their livelihood from dairy farming. However, the farming faces a major challenge of scarcity of land size due to increased subdivision of land resulting from increased population pressure. Therefore the land sizes are small and ideal for zero grazing.

Friesian is most preferred breed by smallholders because of its high milk production for commercial purposes and milk for home consumption. This shows that the productivity of a technology influences the adoption. Most of Friesian milk is sold to the processing dairies. Aryshire breed are also kept because of their high quality of milk characterized by increased solid contents and therefore preferred by most local consumers.

From the findings the study, we noted there is great uptake of AI technology with all the respondents indicating they use AI. Both local and imported semen straws are used. Local straw semen is most preferred because it is cheap and available. Therefore, technologies that are cheaper and more affordable are easily adopted. Although AI is considered cheap, most of the respondents indicated they use AI with expectation of getting high producing heifers and is safe technology to use in dairy cattle. Therefore, technologies that are safe to use are easily adopted.

In seeking to establish the feeding management that the small dairy farmers apply, the study found that most of the dairy farmers feed their cattle on fodder, concentrates and mineral salts. Napier grass is the major fodder grown in the area, because Napier grass has high protein content and grows well in high rainfall areas. There is great awareness in improving animal nutrition among the daily smallholders, with 88.8% of the respondents indicating that they feed their cattle on fodder, concentrates and mineral salts. However, most of the farmers have small land sizes for growing fodder and a majority of the farmers depends on buying fodder. Feed concentrates are given to correct certain nutrients deficiencies, forage and low feed intake by the dairy cattle. The study found that there is great increase in milk production when feed concentrates are added to the animal feeding programme, with over 71% of respondents indicating increase of milk production with more five litres per day. Therefore, technology with more value is adopted than one with less value. Most of the farmers do not give enough feed concentrates to their cattle, citing high cost of animal feed concentrates and low milk prices.

The study established that most of the respondents do not store feed. This is due to small land size for growing fodder due to the subdivision of land into plots resulting from population pressure. Financial constraints were said to be a major challenge in feeding the dairy cattle, with 52.7 % respondents indicating high cost of feed (both concentrate and fodder).

On the seeking of animal health care, the study found that most of the farmers (94%) seek animal health services. The study further established that veterinary doctors are the most preferred animal health services providers due to the high competence of their services.

However, most smallholders are not able to differentiate the veterinary doctors, animal health assistants and livestock officers.

The study found that there are poor vaccinations programmes, whereas diseases control is only done during outbreak of diseases. Most of the respondents (75.5%) mainly vaccinate their cattle during outbreaks. The study also found that most dairy farmers deworm their animal regularly, with 45% indicating regular deworming of their cattle.

Findings on the external parasites control indicated that 67.3% of the respondents spray their dairy cattle against ticks and flies. However, a veterinary doctor in the area indicates high prevalence of ticks borne diseases. The study found that the major challenge of seeking the animal health is the high cost associated with the same. The cost went up with liberalization of the dairy industry.

It is evident that the adoption of dairy farming technology has a socio-economic impact in the area. There is job creation at transfers of the technologies in the area and at the farm level. Such jobs include extension agents who create awareness of the technology and service providers such as inseminators, nutritionists, and animal health providers' animal feed suppliers. At the farm there are animal attendants, jobs created in transporting and handling in the milk processing factory. There is an association among farmers (Githunguri Dairy Farmers Cooperative) which markets and sells farmers' milk. There is creation of wealth, which can be seen in terms of income from milk sales and high valued cattle. Home consumption of milk means improved human nutrition as milk is proved to be balanced diet.

5.2 Conclusion

The study investigated the adoption of dairy farming technologies in Githunguri Division of Kiambu County. Structured and unstructured questionnaires were administered to various respondents. On analyzing the findings the study concluded that effective adoption of dairy farming technologies among small scale dairy farmers is remarkable. Small scale farmers desire a high producing breed of cattle that produces enough milk for commercial purposes and home consumption. Friesian breeds of cattle are the most preferred breed of cattle by the small dairy holders as they produce more milk and

therefore beneficial to the farmer. Therefore, the productivity of technology influences it is adoption.

From the findings of the study, the use of AI among the smallholders has been greatly accepted and well implemented. The research found out that small scale farmers use AI mainly to get cattle daughters that are high producers in term of milk production hence more income from milk sales for the farmer and also enough for home consumption. The cost of AI varies depending on the type of straw of semen desired, with imported semen straw being more expensive. The local straw is mostly used because it is cheap. The study therefore concluded that cheaper and affordable technologies are more easily adopted.

The study investigated the feeding management of small scale farmers undertake. The research findings showed farmers feed their cattle on fodder, concentrates and mineral salts. Although most of the dairy holders are willing to feed their cattle, the study concluded that inadequate fodder grown was limited to small land sizes resulting from increased population pressure. Therefore, dairy cattle's feeding is a major challenge in the small dairy farming. Feed concentrates are supplements given to correct nutrient deficiencies and increase milk production in dairy cattle. From the findings, 71.4% of respondents indicated that concentrates cause increase in milk production in dairy cattle. Therefore, the study concluded that technologies that add more value are easily adopted.

From the findings it was evident that small dairy holders take care of their animal health. Although not regularly, routine practices such as deworming and ticks control are undertaken. The findings further showed that small scale farmers prefer veterinary doctors as their animal health provider because of their competence in animal health service delivery. However, farmers are not able to differentiate veterinary doctors, animal health assistants and livestock officers. Therefore care of adopted technology leads to adoption of another technology. From the study findings, most respondents indicated that animal health care is costly and unaffordable. This has been as result of the privatization of clinical services in 1994, and implementation of the cost of sale of veterinary drugs meant the farmer incurs the full cost of services.

5.3 Recommendations

Various recommendations can be derived from the results of the study

a) Due to land scarcity, farmers should be trained by extension agents on intensive farming technology, whereby they can make use of the limited land space to produce more. Smallholders should be encouraged to maintain the productivity of their dairy cattle during dry seasons by maximizing conservation and storage of feed surplus experienced during wet seasons. Farmers should also be encouraged to diversify the quality of their fodder, for example intercropping of Napier grass with desmodium or other edible legumes.

b) On AI, technology farmers should be advised to use sexed straws semen which have percentage of getting heifers that they demand to have for future milk production.

c) There is need for the government and all stakeholders involved to encourage farmers to join groups so that they can benefit from agriculture extensions. Groups are easier channels to disseminate information. Farmers are also able to lobby for services and can be able to pay for extension services where needs be and this is turn helps to improve their milk production. Improvement of infrastructures such as road, electricity supply and milk cooling plants will greatly enhance marketing of the dairy products and this will not only increase milk for small dairy holders income and but also create job opportunities.

d) With liberalization of dairy industry, the government has shifted its role approach to include private sectors. However the animal health services, extensions and animal feeds have become expensive and the question arises if small dairy holders adequately benefit from liberalization of the industry. There is need for the government to provide legal and policy guidelines that intensifies improvement of animal feeding, animal health services and feed management as important activities in the dairy industry. The government still plays a big part in diseases control. An effective vaccinations programme should be put in place to minimize

chances of outbreaks of diseases and the losses the diseases cause to the small scale farmers.

e) Farmers should be encouraged to diversify the farming to include sales of high value cattle to other farmers. This will not only earn the farmers income but other farmers in other area benefit from the high producers cattle as it has been shown that the adoption of dairy farming technology have positive socio-economic impact

5.4 Suggestions for further study

The researcher suggests further study be done on zero grazing, biogas production and quality of life for farm households.

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APPENDIX 1

QUESTIONNAIRE

Dear Respondent,

My name is Evan Kimunya Gitonga, a student at University of Nairobi currently pursuing Master Degree in Arts Rural Sociology and Community Development. I am carrying out a research on Adoption of dairy farming technologies among small-scale farmers in Githunguri Division of Kiambu County. I would kindly request you t o please spare some time and fill the questionnaire below. The questionnaire will be used strictly for the purposes of the research and assure you of absolute confidentiality. Thanking you in advance for your support

Personal information

1) Please indicate your age bracket

- ☐ 21-35 years
- ☐ 35-50 years
- ☐ 51-65 years
- ☐ Over 65 years

2) Gender Male ☐ Female ☐

3) What is your marital status? Married ☐ Single ☐ Divorced ☐ Separated ☐

Others (specify) …….

4) What is your level of education? Primary ☐ Secondary ☐ Post Secondary ☐

Others (specify) ……

5) What is your Religion background?

Christian Muslim Hinduism Others Specify

6) Which denomination do you belong to?

……..……

7) How many children do you have?

Category	Number of children
Under school age	
In Primary school	
In Secondary school	
In Post Secondary school	
Unemployed	
Employed	

8) How many members of the family live on the farm?

a) Less than 3 persons
b) 3 to 5 persons
c) 6 to 8 persons
d) Others (Specify)….....

9) Of those living on the farm, how many are available for farm work?

……

10) If some family members left the farm, why did they live the farm?

a) Due to lack of land.
b) In search of better incomes.
c) Others (specify)……

Receptability of dairy farming technology

11) Which dairy breed of cattle do you keep?

- ☐ Friesian
- ☐ Aryshire
- ☐ Cross dairy breeds
- ☐ Guernsey
- ☐ Others (specify)……..

12) How did you acquire the breed?

- ☐ Buying
- ☐ Inheritance
- ☐ Gift from friends or relatives
- ☐ Others (Specify)……..

13) Do you use AI for dairy cattle breeding? (Tick) Yes ☐ No ☐

14) If yes, why do you use AI for dairy cattle breeding?

a) Cheap
b) Safe
c) High conceptability
d) Expected heifers/daughters are high producers.
e) Others (Specify)……

15) For how long have you been using the AI?

a) Less than 5 years
b) 5 – 10 years
c) 10 – 20 years
d) Over 20 years

16) Would you recommend another farmer to use AI in his or her dairy cattle?

Yes ☐ No ☐

17) If Yes, why?

a) Cheap
b) Safe
c) High conceptability
d) Expected heifers/daughters are high producers.
e) Others (Specify)…….

18) What do you feed your cattle on?

a) Fodder alone
b) Fodder and concentrate
c) Fodder, concentrate and mineral salts
d) Others (specify)…….

19) Where do you get the fodder?

a) Growing in the farm
b) Buying from other farmers
c) Growing and buying
d) Others (Specify)……..

20) How big is the land size for growing the fodder?

a) Less than an acre
b) 1-3 acres
c) 3-5 acres
d) Over 5 acres

21) Do you have feed storage? (Tick) Yes ☐ No ☐

22) If yes, which type of feed do you store?

a) Hay
b) silage
c) Hay and silage
d) Others (Specify) ……

23) Do you feed your cattle on commercial concentrates (Daily meal, calf pellets, maize germ, and wheat and rice bran)? (Tick) Yes ☐ No ☐

24) If yes, why?

a) To increase milk production
b) To enhance growth of young ones
c) Fattening
d) Others (Specify)…….

25) Supplementing with concentrates, does milk production

a) Increase greatly?
b) Increase slightly?
c) No change
d) Others (specify)…….

26) Wound you recommend another farmer to supplement his or her cow with concentrates? Yes ☐ No ☐

27) If yes, why?

a) Increase in milk production
b) Enhance growth in young ones
c) Others (Specify)…….

28) What are the major challenges encountered in feeding cattle?

……..

Accessibility to animal health care

29) Do you keep animal health record? (Tick) Yes ☐ No ☐

30) If yes, who among the following animal health provider attend to your animals?

a) Veterinary doctor
b) Animal health assistant
c) Community health worker
d) Others (specify)……

31) How frequently are you cattle vaccinated?

a) Yearly
b) During outbreaks of diseases.
c) Others (Specify)……

32) Do you de-worm your cattle? (Tick) Yes ☐ No ☐

33) If yes, how frequent?

a) Every 3 months
b) Every 6 months
c) Once per year
d) Other (specify)…….

34) Do you spray /dip your cattle to control external parasites (ticks, flies)? Yes ☐ No ☐

35) If yes, how frequent?

a) Once per week
b) Once per month
c) Once per year
d) Others (specify)…….

36) What are the major challenges in accessing the animal health care?

a) Is costly

b) Unavailability of qualified animal health provider

c) Other (specify)……..

APPENDIX 2

OBSERVATION GUIDE

1. Size of the land estimated in acres ……..

2. Presence of dairy cattle…….

3. Number of dairy cattle……..

4. Types of dairy cattle grazing…….

5. Presence of cow shed……..

6. Physical condition of the cow……..

.

7. Fodder grown in the farm…….

8. Fodder storage……..

9. Types of fodder…….

10. Presence of water tank/reservoir……..

11. Types of animal health records……

APPENDIX 3

KEY INFORMANT GUIDE

DearRespondent,

My name is Evan Kimunya Gitonga, a student at University of Nairobi currently pursuing Master Degree in Arts Rural Sociology and Community Development. I am carrying out a research on Adoption of dairy farming technologies among small-scale farmers in Githunguri Division of Kiambu County. I would kindly request you t o please spare some time and fill the questionnaire below. The questionnaire will be used strictly for the purposes of the research and assure you of absolute confidentiality. Thanking you in advance for your support

1. Name of respondents (optional)……

2. In your own opinion how would you rate the use of AI in dairy cattle in Githunguri Division?

3. Which is most preferable breed of cattle kept and why?

4. In your opinion how frequently are the animals vaccinated in Githunguri division?

5. What is the recommended deworming regime of cattle in this area?

6. What is recommended dipping/spray against external parasites?

7. Are there any functional community cattle dips in Githunguri Division?

8. If yes, how frequent are the cattle dipped?

9. What is the prevalence rate of tick borne disease in Githunguri?

10. Are Githunguri farmers able to differentiate animal health providers?

11. In your own opinion, which are the major challenges dairy farmers' faces in Githunguri Division?

12. In your own opinion which is the major socio-economic benefits associated with adoption dairy farming technologies?