FACTORS INFLUENCING ADOPTION OF DAIRY GOAT FARMING IN KIAMBU EAST DISTRICT, KENYA

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NOVEMBER, 2011

DECLARATION AND RECOMMENDATION

Declaration

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

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Recommendation

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DEDICATION

This work is dedicated to my wife Josephine and our children; June and Ryan, for their never ending support, prayers and encouragement; my mother Rachael, who sacrificed so much to give me head start in education.

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ABSTRACT

Kiambu East District has dairy farming as the dominant agricultural activity; however the diminishing land size as a result of rapid population increase poses a major challenge to its dairy production. Dairy goats, due to their low feed requirement provide a feasible supplement to dairy cattle-the predominant dairy enterprise, but their adoption is low. This study aimed at establishing; whether or not, there was a relationship between farmer perception about dairy goats' attributes and their adoption and other factors (socioeconomic and access to breeding stock) that influenced adoption of dairy goat. Using semi structured questionnaires the researcher and trained enumerators interviewed 120 randomly selected dairy farmers. Spearman's rank correlation showed that there was indeed a positive relationship between farmer perception and adoption of dairy goats. The Logit regression analysis showed that availability of dairy goats, availability of technical information, access to credit and farm size were the factors influencing adoption of dairy goats. The study findings are useful to extension agents, researchers and policy makers. To supplement diminishing public extension service, facilitation on formal education expansion should be given priority for future improvement of technology adoption. Credit could be made available to farmers to build up the capital required in starting up dairy goat enterprise. Farmer groups need be strengthened as vehicles of information gathering, production and marketing. Policy makers should focus on providing dairy goat farmers with affordable AI scheme to solve the problem of lack of breeding stock. Policy makers should also focus on research geared towards improvement of the productivity of dairy goats.

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ABBREVIATIONS AND ACRONYMS

HIV	- Human Immune Deficiency Virus
AIDS	- Acquired Immune deficiency Syndrome
ARVT	- Anti Retroviral Therapy
Ha	- Hectare
CIMMYT	- International Maize and Wheat Improvement Centre
MFI	- Micro Financing Institution
ROSCAS	- Rotating saving and Credit Associations
DGAK	- Dairy goat association of Kenya
TLU	- Tropical livestock units

CHAPTER ONE: INTRODUCTION

1.1 Background

Livestock is a key resource in African agriculture (IAC, 2004) and is found in a range of agricultural production systems. The majority of goats in Kenya are kept in arid and semi-arid land. In high potential areas, a zero-grazing, tethered or stall-fed system is often used (Okeyo, 1997). Like the rest of the developing world, the African livestock sector experiences rapid changes due to a number of factors like demographic, economic development, environmental and climatic changes, available technologies and knowledge as well as other factors (Moyo et al, 2009).

It is generally recognised that livestock has the potential to make a significant contribution to food security, poverty reduction and improved livelihoods amongst smallholder livestock producers in Africa and globally (Winrock International, 1992; Perry et al., 2003). In Africa, the population growth rates are among the highest in the world, with an average of 2.3% per year between 1999 and 2004 (World Bank, 2009). In the same period the urban population increased with 3.89% per year. In coming years, consumption of livestock products is expected to increase. It is projected that there will be a change in per capita consumption of 60% for milk by 2030 in developing countries (IAASTD, 2007). This calls for enhanced adoption of dairy to cope with this anticipated change.

In Kenya, the livestock sector accounts for 12% of the total GDP, 47% of the agricultural GDP while, at the same time, supplying the domestic requirement of meat, milk and products among other livestock products that account for 30% of the total marketed agricultural produce (GOK, 2010). This sector had, in the past, successfully met the demand for meat and milk. However, for the past two decades the sector has not been able to meet the increased demand, especially for milk, arising from population explosion and rapid urbanization (Ahuya, 2007). Per capita milk consumption in Kenya stands at 80 litres per person per year against the FAO recommendation of 120 litres per person per year (FAO, 2005).

The high agricultural potential areas of Kenya are densely populated with about 88 persons per square kilometre (FAO, 2005), leading to reduced land for livestock production, particularly cattle. Availability of feed resources both in terms

of quantity and quality required for the intensification of livestock production is a key constraint in these areas. Rearing of small ruminant animals such as dairy goats is therefore a more sustainable option for enhancing food security at household level amongst smallholder farmers (Ahuya, 2007). Kiambu East district exemplifies densely populated high potential areas of Kenya. Dairy goat is considered the cow of the poor. The goat eats little, occupies a small area and produces enough milk for the average unitary family, whereas maintaining a cow at home cannot be afforded by the homeowner, hence the growing popularity of goats as the poor person's cow.

Dairy goats produce about 15.2 million metric tons (MT) of milk, accounting for about 2% of the world total amount of milk produced by livestock species (FAOSTAT, 2008). The developing countries produce approximately 83% of the total amount. Dairy farming is an important livestock activity in Kiambu East district, contributing immensely to the district's economic earning. In 2007 the district earned Kenya shillings one billion from livestock and out of this dairy contributed Kenya shillings nine hundred and six million (906 million) from the sale of milk formally through cooperative societies (GOK, 2007). However, land is highly fragmented with an average land holding of 0.8Ha amongst the smallholders and there is need to promote farming activities that requires limited land such as rearing of dairy goats. Further, the proximity of the district to Nairobi city provides a ready market for the dairy goat products. Dairy goats could complement or even substitute dairy cattle farming in this district.

Dairy goat industry in Kenya faces numerous challenges. Of particular significance is the seasonality of their reproduction, due to their seasonal reproductive cycle, whose implication is that all year round supply of milk cannot be guaranteed. Secondly, there is the consumers' perception that goat milk products have goat odour or taste. Thirdly, there have been very few successful government managed goat-breeding programmes in Kenya (Peacock, 2005). Although government-managed goat breed improvement programme have no lasting impact, an appropriate and cost-effective method of breed improvement involving farmer groups managing the multiplication of the breed used to improve local breeds, have been reported (Ahuya, 2007). This raises hope for breed improvement and consequently goat productivity.

The government in its endeavour to support dairy goat farming has advanced farmers grants to buy dairy goats through a food security programme dubbed Njaa Marufuku (English translation is do away with hunger) (GOK, 2007). Despite the potential of dairy goats in the district and support from government, their adoption remains low. This study therefore, focused on factors that influence the adoption of dairy goat farming in the district.

1.2Statement of the problem

There are two main dairy activities in Kiambu East district; dairy goats and dairy cattle farming. The proximity of the district to Nairobi city coupled with rapid population increase has resulted in land sub-division for both agricultural and non-agricultural uses, which is affecting the farming system in the district. Reduced land for fodder production may shift farming towards more intensive agriculture. This favours dairy goats farming to dairy cattle farming because of their less demand for fodder, additionally there are deliberate government efforts to encourage dairy goat farming through funding.

However, despite their potential and the problem of diminishing land sizes, dairy goat adoption by farmers remains low. It is therefore important to understand the reasons for the poor adoption of dairy goats in the district. This information will be useful to development agencies and policy makers.

1.3 Objectives of the study

The broad objective of this study was to determine the factors responsible for low adoption of dairy goat farming in Kiambu East District, Kenya. The specific objectives were to determine:

- The correlation between farmer's perception of dairy goats and their adoption;
- Socio-economic factors influencing adoption of dairy goats;
- The influence of breeding stock availability on adoption of dairy goats.

1.4 Hypotheses of the study

To achieve the objectives of this study, the following hypotheses were formulated:

- Farmers' perception of dairy goats has no correlation with their adoption;
- Farmer's socio-economic factors do not influence adoption of dairy goats;
- Access to breeding stock does not influence adoption of dairy goat.

1.5 Justification of the study

The per capita milk consumption in Kenya is low perhaps due to inadequate availability of milk. Landholding in high potential areas such as Kiambu East district is diminishing rapidly favouring rearing of dairy goats. Understanding the low adoption of dairy goats in Kiambu East district would help towards improving dairy goat farming. This would lead to increased milk production in the district, employment creation and a source of income.

There have been allegations amongst the general public that goat milk is nutritive for individuals living with HIV/AIDS. This potentially creates a niche market for goat milk; it would be necessary to verify from the dairy goat farmers where they sell their milk and consequently know whether truly there is a market for goat milk or not thus increasing returns for small scale farms.

Given the scanty information available on dairy goat adoption, this study will fill existing knowledge gap and contribute to the planning of dairy goat projects in the country. Besides, the results of the study could be used in other parts of the country with similar constraints.

1.6 Definition of terms

Dairy goats: These are milk goats exotic to Kenya and they include Saanen, Anglo-Nubian, Toggenburg, German Alpine and their crosses with indigenous goat breeds.

Adopters: Farmers with at least one dairy goat/crossbreed at the time of the survey.

Non-adopters: Farmers keeping dairy animals other than dairy goats or their crosses at the time of the survey.

Household: This is a social group which resides in the same place, and makes joint or co-ordinated decisions over resource allocation and income pooling, Adopted from Ellis, (2000).

1.7 Scope and limitations

This study was restricted to factors that influence adoption of dairy goats in Kiambu East District. However, other than the farmer's perception, the goat milk consumer's perception can influence demand and hence adoption by the farmer. The current study did not deal with the consumers' perception/attitude and could be an opportunity for further research. There is scanty literature available on the adoption of dairy goats; therefore there wasn't much to borrow from. The study was restricted to Kiambu East ditrict.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Adoption of technological innovations by farmers in developing countries has attracted considerable attention. This is because majority of less developed countries derive their livelihood from agricultural production, yet many new agricultural innovations in these countries have been met with partial success as measured by rates of adoption (Feder and Zilberman, 1985). According to Van de Ban and Hawkins (1998) adoption is a mental process through which an individual passes from first knowledge of an innovation to the decision to adopt or reject and to confirmation of this decision. According to Feder et al (1985) adoption refers to the decision to use a new technology, method or a practice by a firm, farmer or consumer. As indicated by Dasgupta (1989), adoption is not a permanent behaviour.

An individual may decide to discontinue the use of an innovation for a variety of personal, institutional or social reasons, one of which could be the availability of an idea or practices that is better in satisfying his or her needs. Dasgupta (1989) indicate that, the decision to adopt an innovation is not normally a single instantaneous act, it involves a process. The adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. According to Dasgupta (1989) decision-making process is the process through which an individual passes from first knowledge of an innovation, to forming an attitude towards an innovation, to decision to adopt or reject, to implementation of new idea, and to confirmation of the decision.

The adoption or rejection of an innovation is the consequence of diffusion of an innovation (Dasgupta 1989). Diffusion is a process by which new ideas are communicated to the members of a social system (Rogers and Shoemaker, 1971). An innovation is an idea, method or object which is regarded as new by an individual, but which is not always the result of recent research (Van De ban and Hawkins, 1998). Diffusion and adoption are thus closely interrelated even though they are conceptually distinct (Dasgupta, 1989).

The adoption pattern to technological change in agriculture is a complex process. A large number of personal, situational and social characteristics of farmers

have been found to be related to their adoption behaviour. According to Dasgupta (1989), adopters have a high rate of literacy and higher level of formal education, operate large sized holdings, own the land they operate, have a relatively high income and economic status, are commercial in farming operations, have relatively high level of extension contact, and belong to upper socio-economic status categories. On the other hand, non-adopters have low rate of literacy and level of formal education, operate smallholdings, are mostly small and marginal farmers, belong to low income group, have a low level of socio-economic status categories.

Farmers' assessment of the performance of a trial technology is crucial and the most important part of technology evaluation. Farmers are rational in their decision-making. They will only decide to adopt technology if they are convinced of its benefits and if the technology does not require unacceptable efforts on their part. Therefore, involving farmers as active participants in the evaluation of recommended technological innovations can have several benefits for technology generation by agricultural research stations. This helps in getting a full understanding of the criteria farmers use to decide whether to adopt or reject recommendations (Bunders et al., 1996)

2.2 Role of dairy goats

Goats provide a broad range of products and socio-economic services and have played an important role in the social life of many African people. They are used as gifts, payment of dowry, and in religious rituals and rites of passage (Peacock, 1996). Dairy and dual purpose goats' contribution to improved livelihoods of resource poor in the more densely populated areas of Kenya was recognized in the early 1980's (Bradford et al, 1983) and remains important even today.

Kenya's dairy-goat industry is rapidly growing and contributes immensely to improved human nutrition by providing milk and farm income. Besides, small ruminants have shorter reproductive cycle and high incidences of multiple births, which are advantageous over cows. Their small size and early maturity makes them especially suitable for use on small scale farms (Devendra and Burns, 1983).

Dairy goat milk can be used to mitigate effects of HIV/AIDS by providing nutrients necessary for patients on ARVT (Girja and Muliokela 2006). Due to high

level of poverty prevalence, significant numbers of patients receiving ARVT are food insecure and therefore, milk and milk products consumption can play a good nutritional support.

The nutritional value of dairy goat milk cannot be over emphasized. The milk is easier to digest than cow milk and can be of value to adults and babies unable to digest cow milk (Knox, 1998). The major difference between cow and goat milk is that the fat globules are much smaller in goat milk, has distinct alkalinity, higher buffering capacity and certain therapeutic values (hypo-allergenicity). Other than the nutritional aspect, dairy goats' labour requirement is less compared to dairy cattle which make them appropriate for people living with HIV/AIDS (Ahuya, 2007).

2.3 Overview of factors influencing adoption decision

According to Feder et al (1985) adoption is the degree of use of a new technology in the long run equilibrium when a farmer has all the information about the new technology and it's potential. Therefore, adoption at the farm level reflects the farmer's decision to incorporate a new technology into the production process.

To meet the rapidly growing food demand and to raise the rural incomes, it is believed that farmers must increase farm production and productivity (Wetengere, 2009). Farm production can be increased through putting more land to use or applying new technologies (Wetengere, 2010). Scarborough (1996) observed that sustainable increases in agricultural productivity could be obtained even with the available land only through technological and managerial innovations. Improving farm production through integrating modern technology into the existing farming system is essential for enhancement of the household food and income security (Wetengere, 2009).

To improve the agricultural production, some form of appropriate technology is necessary. Appropriate technology in this context refers to the latest technological development that has been adjusted to suit the local conditions to the highest possible degree (FAO, 1996). Many technologies are becoming available to farmers but not adopted by the majority of the farmers. The question arises why these new technologies are not usually adopted by farmers. Is it the lack of compatibility of new technologies with the existing farming systems and/or are there socio-economic factors that inhibit and constrain their adoption? (Sheikh et al., 2003).

According to World Bank (2001) poor understanding by researchers and extension staff of the circumstances of the farm household (that is the lack of farming system perspective) and poor linkage between researchers, extension staff and farmers are associated with an inability of applied institutions to develop or adapt a technology that is appropriate for many of the common farming systems.

According to Rogers (1995) the rate of adoption of new technologies depends on socioeconomic characteristics, personal factors and communication behaviour. These characteristics include age, years of education and size of the farm. Tripathi and Psychas (1992) reported that socioeconomic factors which determine whether individual farmers and communities choose to adopt a farming technology as land tenure, labour requirements, management complexity and profitability.According to Griffin et al., (1995) the rate of adoption of a new technology is subject to its profitability, the degree of risk and uncertainty associated with it, capital requirements, agricultural policies and socioeconomic characteristic of the farmer.

Factors influencing the adoption of new agricultural technologies can be divided into; farm and farmers' associated attributes, attributes associated with the technology (Adesina and Zinnah, 1992; Misra et al., 1993), the farming objective (CIMMYT, 1988) and the perception about the agricultural technology (Feder et al., 1985). Factors in the first category include the farmer's education level, age, and family and farm size. The second category varies with the type of technology, e.g., the characteristics a farmer prefers in a particular technology. The third category assesses how different strategies used by the farmer, such as commercial versus subsistence farming, influence the adoption of technologies.

The variables expected to be positively correlated with the adoption of new technologies are: (1) the information-related variables; namely, years of schooling and farmer's age, (2) the availability of household labour, (3) farm-level endowments, namely rainfall zones and locations, (4) land tenure of agricultural land, (5) non-farm source of income and total income of the household and (6) the household structure (Al-Karablieh and Salem, 1999; Morris and Doss, 1999; Sarap and Vashist, 1994).

In a study conducted in Nepal (Karki, 2004) assessed the impact of foreign-aided project in technology adoption and food security in smallholder peasants, using a logit binomial model.

The results showed that timely availability of credit, years of schooling, off-farm income, extension service, project intervention, farm size and experience of the farmer significantly influenced their adoption decision. Issues relating to farmers membership to an organization, distance to the market, household labour and farmers attitude were not addressed by the study.

Adesina and Baidu-forson (1995) investigated the influence of farmers' perception of technology characteristics on the adoption of sorghum in Burkina Faso and Guinea. Using a Tobit model, they reported that farmers' perception significantly affected their adoption decision, therefore there is need to expand the range of variables used in evaluating determinants of adoption decision to include perception.

Mussei et al. (2001) studied the adoption of improved wheat technologies and fertilizer by small-scale farmers in Mbeya District, Southern Tanzania. Their Tobit analysis showed that farm size, family size, and the use of hired labour were significant factors affecting the proportion of land allocated to improved wheat. Farm size, family size, hired labour and credit all significantly affected the amount of fertilizer used. This study however, failed to examine how the distance to the wheat market, level of education, attitude towards the improved technology, extension intensity and farmer's membership to an organization influenced adoption.

Baltenweck and Staal (2000) studied the determinants of adoption of dairy cattle technology in the Kenya Highlands. They found that the estimated probability of access to credit had significant and positive effect on the decision to adopt dairy cattle technology. Farmers with larger land size adopted faster, reflecting higher savings from crop activities as well as greater potential for growing fodder. Education level played a positive role in the adoption decision while older household heads tended to adopt less, reflecting a possible higher risk aversion. Time played a key role in adoption of dairy cattle technology.

Mburu et al (2008) investigated factors influencing determinants of the magnitude of transaction costs in the ex-ante and ex post stages of dairy goat adoption process in Meru south and Meru Central of the eastern Kenyan highlands. Using a sample of 165, they found that dairy goat adopters were likely to bear significantly more costs than the non-adopters. This implies that the adoption process is not a costless activity because farmers who opt for the technology have to contribute their own resources. However, this study did not consider other factors influencing adoption such as farmers' perception of dairy goats neither did it address the issues of milk market, membership to a cooperative or other farmer's organization and their attitude.

2.4 Methodologies used in adoption studies

Various models have been used to analyse socioeconomic factors affecting adoption of technologies. Widely used are Tobit, Logit and Probit regression models. The Tobit model measures both the probability of adoption and the intensity of the adoption of the technology in question (Maddala, 1992). Works that have used the Tobit model includes Adesina and Baidu-Forson (1995), Adesina and Zinnah (1993) and Sall et al. (2000) among others. Both Probit and Logit models have also been widely used to determine probability of farmer to adopt a given technology. The choice between the two is dependent on convenience and program availability (Amemiya, 1981). Studies that have used logit regression model include works by Judicate et al. (1998), Karki (2004) and Gamba et al. (1998) among others.

2.5 Conceptual framework

The conceptual framework of the factors influencing decisions by small-scale farmers in dairy goat adoption is presented in Figure 1. The study conceptualizes that small-scale farmer's make adoption decisions as a result of interaction of several variables. Generally the decision to adopt/not adopt depends directly on the farmer perception of dairy goats, characteristics specific to small-scale farmers and the farm, economic and institutional factors. However adoption/ non adoption may as well be influenced by the indirect effect of farmers and the farm characteristics, economic and institutional factors on farmer perception of dairy goats.

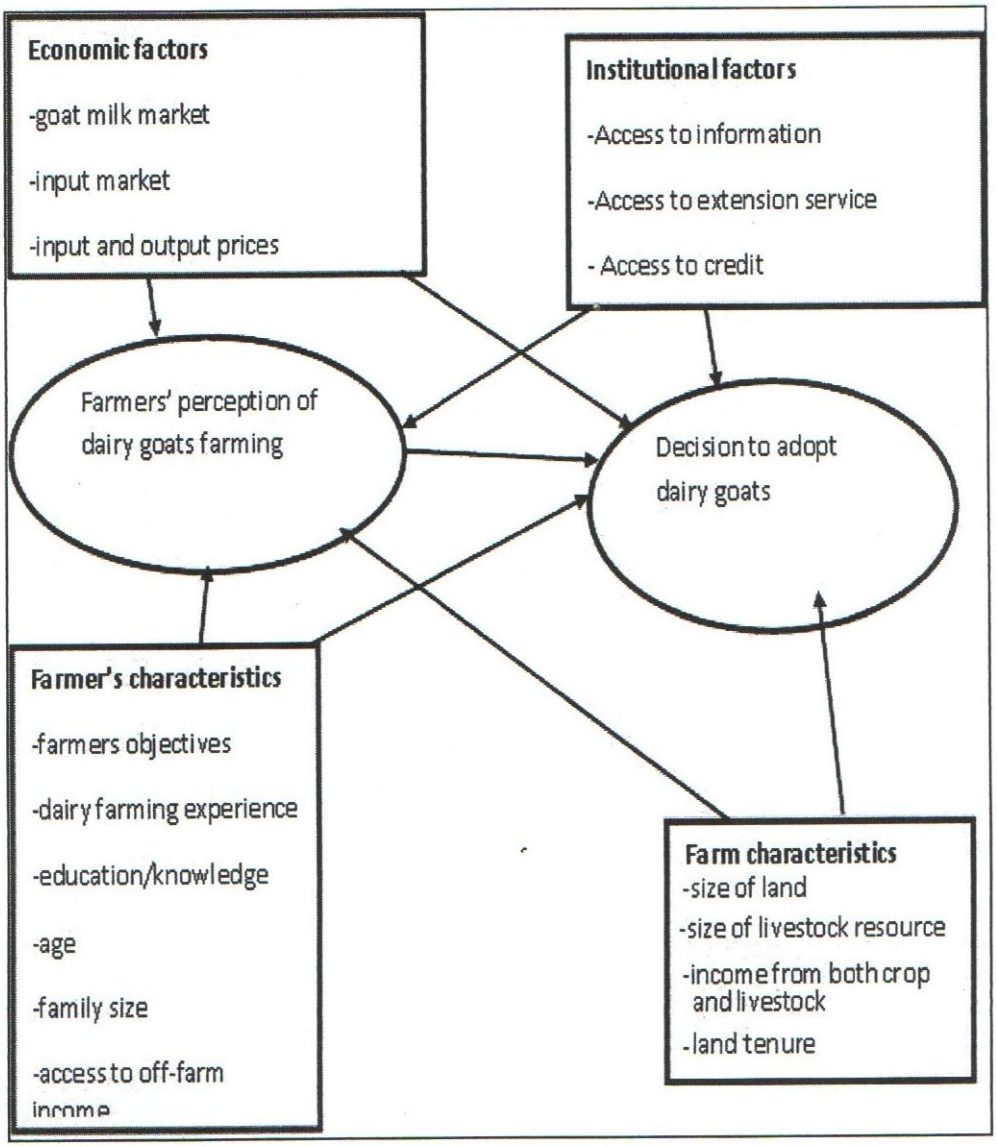

Figure 1: Conceptual Framework (Adapted from Holden and Shiferaw, 1998)

Farmer's perception of dairy goats can be influenced by farm characteristics (farm size and number of livestock other than dairy goats) institutional factors (access to information, extension service and credit), farmer's characteristics (farmer's objectives, experience, age, family size and access to off-farm income) and economic factors (goat milk prices, input and output prices and goat milk market). When the farmer perceives dairy goats favourably and is convinced that they are compatible with other farm enterprises, they are not delicate to handle and that the results of keeping them are observable, then he/she makes the decision to adopt them (Rogers, 1995). The decision to adopt dairy goats is the dependent variable, while and the

independent variables are economic, farmer characteristics, farm characteristics and institutional factors. In Figure 1, Perception is both an independent as well as an intervening variable

2.5.1 Characteristics of farmers

In particular the objective, knowledge and attitude of small-scale farmers could have an influence on dairy goat adoption (Sutherland, 1987). Small-scale farmers normally have multiple objectives of keeping livestock (a cash resource, financial security, source of wealth, provide animal products, payment of bride price and social status) and these are likely to influence the decision making process. The education (both formal and informal) is an important characteristic that influence adoption decision. It also increases the managerial capacity of small-scale farmers and hence the ability to comprehend complicated information related to modern dairy goat production (Scarborough, 1996).

The frequency with which the farmers have contact with extension agent and the degree to which the farmer relies upon agents' people for goat management would be important in the acquisition of informal education. The availability of family labour would provide the necessary labour to feed, milk and tend dairy goats.

Cash availability and access to credit is often found to increase the probability of adoption of new technology (Ahmed and Ehui, 2000). Due to cash constraint the farmer might not afford the necessary expensive inputs related to the new technology. On the other hand, higher off-farm income might reflect higher opportunity cost of labour on the own farm and adopting new technology. Wealthier farmers are more likely to adopt new technology because of better financial resource, higher education level and better social networks. Social networks might alleviate labour constraints and increase information flow about new technology and therefore influence adoption decision (Boahene et al, 1999).

The study conducted by Nkonya et al., (1997) on factors affecting adoption of improved maize seed and fertilizer in northern Tanzania, indicated that farmer's age did not significantly influence improved technology adoption.

2.5.2 Farm characteristics

Important farm characteristics include the size of land, income from both crop and livestock, size of livestock resource and the climatic condition prevailing in the area (Emad et al., 2009). Much empirical adoption literature focuses on farm size as the first and probably the most important determinant. Hence farm size is frequently analysed in many adoption studies (Nkonya et al., 1997; Adesina and Baidu-Forson, 1995 and Baidu-Forson, 1999). The characteristics of a particular farm or the type of production system influences adoption decision. The level of market orientation and the intensification of the production system are important factors influencing adoption decision, as these determines the degree to which the system relies on inputs and modern technology. Land tenure security affects adoption decision as insecurity of land rights is regarded as an important deterrent of long term land investment decision (Gebremedhin and Swinton, 2003). Apart from its direct incentive for long term investment venture (like construction of housing structures), properly secured tenure with tradable or transferable rights reinforces yield enhancing efforts by relaxing the credit market constraints and by providing collateral in the credit market.

2.5.3 Economic factors

These include the existence of market for goat milk as well as availability of inputs (such as, feeds, drugs, breeding stock among others), the level of input prices and the demand and supply relationship (Little, 1984; Nji, 1993). It is often discussed in literature that rural markets and institutions in developing countries are generally poorly developed and characterized by high transaction costs, arising from transportation costs and limited access to information, capital and credit. Existence of market for products will influence production and adoption decision of dairy goats. Lack of market for products would imply disincentive to adopt, farmers would be unwilling to produce products that will not sell in the market. With regard to input and output prices, livestock producers are responsive to changing conditions of profitability and trade, as prices play a central role in production decisions (Ali, 1995). Demand and supply of livestock and livestock products influence adoption decision as they relate to market prices and hence profitability (Tripathi and psychas, 1992).

Falling demand relative to supply depresses prices and consequently farmers are less likely to allocate resources to pay for new technologies. In addition, the existence or non-existence of input market is important. If inputs, including breeding stock, are not available or only available at high prices, technology uptake will be limited.

2.5.4 Institutional factors

These relates to marketing infrastructure, information sources, extension service, availability of credit and membership to farmer organization. Marketing infrastructure implies organised marketing systems that are supported by government policy (Emad et al., 2009). The existence of well organised marketing system that ensures ready and accessible market for farm produce motivates investment into agricultural activities. Affordable market prices for inputs will encourage proper use of inputs. Dependable information facilitates farmers to make informed decisions on production and marketing of output. Acquisition of information about a new technology demystifies it and makes it more available to farmers. Information reduces the uncertainty about a technology's performance hence may change individuals' assessment from purely subjective to objective over time (Caswell et al., 2001). Exposure to information about a new technology as such significantly affects farmer's choice about it. Information is acquired through informal source like the media, extension personnel, visits, and meetings and through formal education. Availability of affordable credit will relax financial constraint on farming. Membership to farmer organisation and dairy cooperatives could be helpful in three ways (1) a group has better access to formal credit than individual farmers (2) external support or training from the public or private sector is easier in groups and (3) credit schemes could be easily organised within a group (Ahmed and Ehui 2000).

2.5.5 Perception

This is the process through which one gains an understanding of what is happening and forms an opinion or attitude towards it. The way farmers perceive attributes of a given technology influences their adoption behaviour. According to Rogers (1995) there are five attributes upon which an innovation is judged. These are relative advantage, compatibility, complexity, triability and observability. Relative advantage refers to the degree to which dairy goats are perceived better than the

indigenous goats they replace or competing dairy cattle. Relative advantage is expressed in terms of economic, social or other benefits obtained from dairy goats. Farmers are interested in knowing whether dairy goats yield higher amounts of milk, are less susceptible to diseases are more timid compared to the indigenous types, there is a market for dairy goat milk or is it negatively influenced by consumer attitude?.

Compatibility refers to the degree to which dairy goats are perceived by potential adopters to be consistent with their existing values or practices. Compatibility with the other livestock enterprise already in place makes dairy goats seem less uncertain, more familiar and easier to adopt. Complexity refers to the degree to which an innovation is considered difficult to understand and use. If potential adopters perceive dairy goats to be complex, their adoption rate will be low. Observability refers to the degree to which the results of dairy goats are visible to others. Studies by Adesina and Baidu-Forson (1995) and Adesina and Zinnah (1993) have shown that farmer's perception of technology specific attributes of agricultural technologies influence preference and hence adoption decision. Work by Wheeler (2005) has pointed perception about risks and profitability; uncertainty about adoption; amount of required information and attitude about risk and uncertainty to influence adoption of new technologies by farmers. On the whole perception is influenced by interplay of farm, farmer characteristics, institutional and economic factors. The resulting perception of farmers about dairy goats based on these factors will help them in deciding whether to adopt or not adopt dairy goats.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the study area and its choice, methodological procedures that were used in data collection and analysis. These procedures include research design, nature of the data, the sampling procedures, instruments, methods of data collection and analysis.

3.2 Study area and its choice

The study was conducted in Kiambu East district. This is one of the districts in Kiambu County. It shares boundaries with Nairobi and Kajiado to the South, Kiambu West to the West, and Gatundu district to the East. It has three administrative divisions Municipality, Kiambaa and Githunguri (See Figure 2(a) and (b)). It covers a total area of 476.2 square kilometres, out of which 380.96 square kilometres are arable; which translates to 80% of the total land. The district receives bimodal rainfall i.e. long rains in the month of march/April through June (250-1600mm) and short rains in the month of October/November through December (100-1200mm).The district's population is 1,623,282 according to the 2009 national census (KNBS, 2009). Both crop and livestock farming are practiced with livestock farming particularly dairy leading in terms of importance.

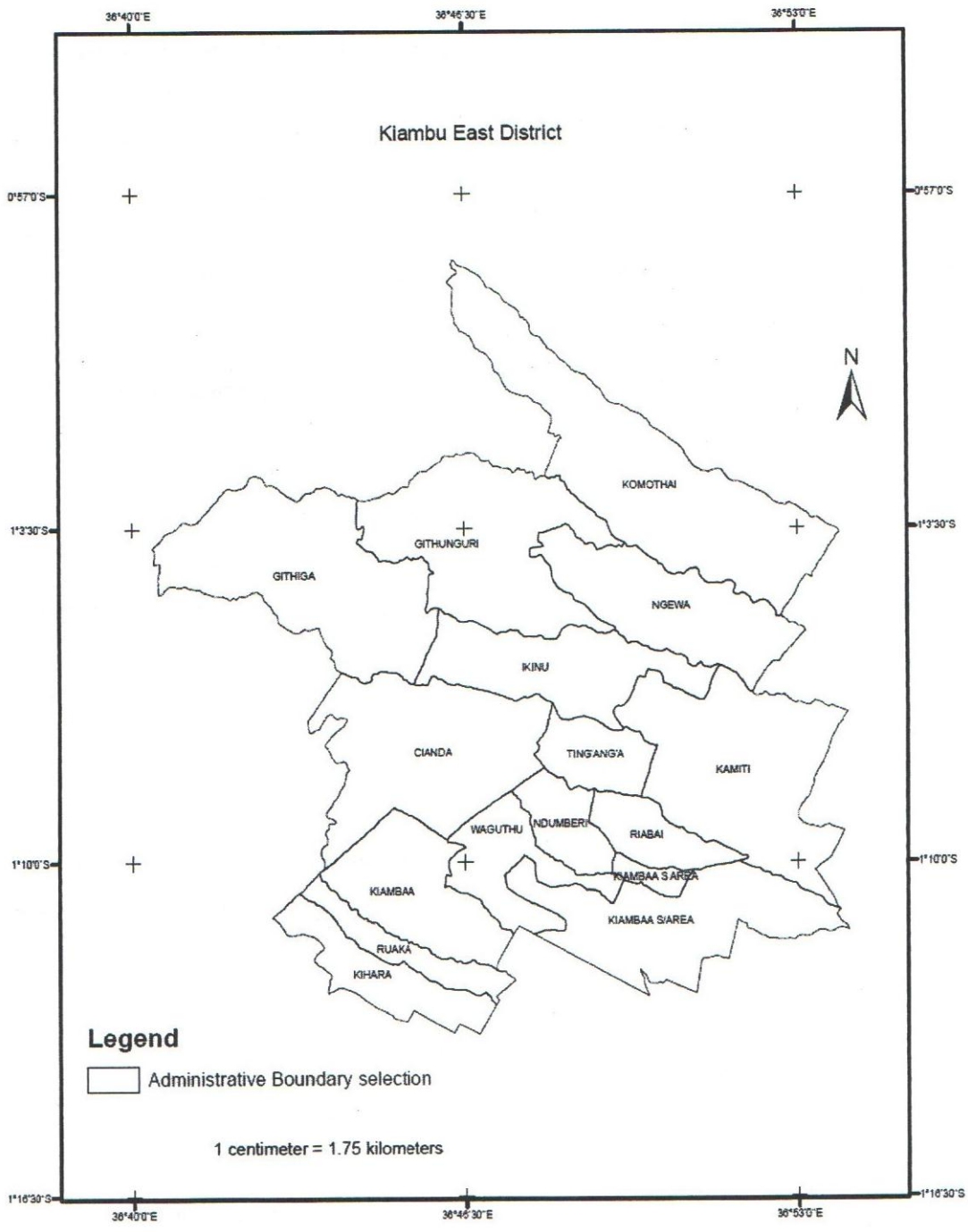

Figure 2: Map of Kiambu East District

3.3 Research Design

A semi structured questionnaire (Appendix I) was used to obtain primary data from the households. The questionnaire captured ordinal and nominal data as per the study objectives for both descriptive and inferential statistical analyses. In addition, a survey notebook was used to capture any unique additional information, either volunteered by the respondent or observed during the survey. This information was used to describe the study area, characteristics of technology adopters and non-adopters and in offering an explanation for some study findings.

The questionnaire had two sections. Section I was designed to obtain socioeconomic household information, while section II obtained information on household perception of dairy goats.

3.4 Sampling procedure and sample size

The sampling units of the study was households keeping dairy animals obtained from the three Divisional Livestock offices of Kiambaa, Municipality and Githunguri and the Dairy Goat Association of Kenya (DGAK) office in Kiambu East district.

On determination of the sample size, Nassiuma (2000) says that in most surveys or experiments, coefficient of variation of at most 30% are usually acceptable. In order to arrive at reasonable sample within a constraint budget, this study assumed a coefficient of variation of 22% and a standard error of 0.02. Sample size was determined using the formula below by Nassiuma (2000).

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where n = Sample size

N = Population

C = coefficient of variation

e = Standard error

In this case; $$n = \frac{52200(22\%)^2}{(22\%)^2 + (52200-1)(0.02)^2} = 120.$$

Therefore a total of 120 dairy farmers were interviewed out of 52,200 dairy farmers in the district.There were a total of 13920 dairy goats' farmers (adopters) and 38280 dairy cattle farmers (non-adopters) in the district (see Table 3.1); two strata based on adoption and non-adoption was constructed from the data provided by the divisional offices. A stratified random sample comprising 26.7% adopters and 73.3% non-adopters were included in the study sample.

A table of random numbers was used to draw a proportionate sample comprising 41% farmers from Municipality, 31% farmers from Kiambaa and 28% from Githunguri divisions in the adopter category. This translated to 13, 10 and 9 dairy goat farmers respectively. In the non-adopter category 58% farmers were randomly selected from Githunguri, 24% from Kiambaa and 18% from Municipality. This translated into 51, 21 and 16 farmers respectively. This was done to give each dairy farmer in the division an equal opportunity of inclusion into the sample, such that the inclusion of any dairy farmer did not in any way deny any other member a chance of inclusion into the sample.

Table 1: Distribution of dairy farmers in Kiambu East district

Division	**Dairy farmers**		
	Dairy goats	**Dairy cattle**	**Total**
Githunguri	3,914	22,186	26,100
Kiambaa	4,350	9,222	13,572
Municipality	5,656	6,872	12,528
Total	**13,920**	**38,280**	**52,200**

3.5 Data collection

A pretesting survey was conducted on 20 dairy farmers in Gatamaiyu division which has similar characteristics to the sample area. This exercise enabled the researcher get a better view of whether the data capture instrument would provide the required data for the study. Consequently the questionnaire was revised to solicit the necessary information.

Three enumerators were recruited per division and trained on how to administer the questionnaire. The questionnaires were administered face-to-face with each household head, where necessary clarifying items in the instrument which might not have been clear to them and carefully recording the responses. This data in the questionnaire and notebooks formed the primary data. Secondary data was also obtained from the divisional and district livestock reports.

3.6 Data Analysis and Procedure

To determine which factors influenced adoption of dairy goats, the collected raw data was coded and entered in STATA program (Intercooled STATA version 9). The data was cleaned by ensuring that all the data was properly entered and any missing values on the data sheet were appropriately sourced from the questionnaires and fitted accordingly. None of the adopters rented in land and therefore rented-in column was deleted from the data sheets. This was found necessary because STATA would treat such columns as missing and therefore fail to run the analysis. The following analyses were done; mean and standard deviation for continuous variables, percentages for categorical variables, Spearman's coefficient of rank correlation and a Logit regression econometric model.

Independent two-sample t-tests were used to test whether quantitative variables of farm and farmer characteristics of dairy goat adopters and non-adopters were significantly different. The p-value approach was used to assess the significance of each model variable, the rejection rule being reject Ho if p-value $\leq \alpha$.

Chi-square ($\chi 2$) was used to test whether qualitative variables on farm and farmer characteristics among adopters and non-adopters were significantly different.

The p-value approach was used to assess the significance of each model variable rejection rule was reject H0 if p-value $\leq \alpha$.

Spearman's coefficient of Rank correlation (rs) was used to determine the relationship between farmer perception and adoption of dairy goats. A logit model was used to establish socioeconomic factors influencing adoption of dairy goats, influence of access to technical information and breeding stock to adoption of dairy goats.

3.6.1 Estimation of Correlation between farmer perception of dairy goats and Adoption decision

Farmer's perception of dairy goats was hypothesized to correlate with adoption. This was in line with the first objective. To achieve this objective, two Rank Order Correlation (rs) analyses was done. This was based on the fact that farmer's perception was ordinal-data type and does not require the normality assumption.

To construct perception index dairy farmers were asked to react to ten (10) statements relating to the attributes of dairy goats (see section II in Appendix I). Each of the response was scored on the Likert scale. Thus, strongly agree was scored 5, agree 4, uncertain 3, disagree 2 and strongly disagree 1.

The summation of the individual score yielded the perception index for each of the sampled households. This was informed by the findings of Mclver and Carmine (1981) that it is very unlikely that a single item can fully represent a complex theoretical concept or any specific attribute. According to Nunally and Berstein (1994), summing up the individual scores usually averages out measurement errors. The following perception indexes were revealed;

10 * 5 = 50 was the most favourable perception index

10 * 3 = 30 was a neutral perception index

10 * 1 = 10 was the most unfavourable perception index

Therefore, farmer's perception of dairy goats was expected to fall between 10 and 50. If the perception index exceeded 30, then the farmer was assumed to have a

favourable perception of dairy goats. If the perception index was below 30, then the farmer was assumed to have unfavourable perception of dairy goats.

Since the farmer's perception was an ordinal type of variable, multiple regression model was used to address the first study objective. The model assumed could not have been the best model to use, because of its normality assumptions (Mukras, 1993). Therefore, the degree of association between adoption decisions was estimated using Spearman's rank correlation. To achieve this objective the following null (H0) and alternative (H1) hypotheses were tested;

H0: There is no significant correlation between farmer perception of dairy goats and adoption decision.

H1: There is a significant correlation between farmer perception of dairy goats and adoption decision.

3.6.2 Factors influencing farmer decision to adopt dairy goats

To investigate the factors influencing dairy goat adoption, the data was analysed using the limited dependent variable regression. Adoption is treated as a binary variable, either adopted or non-adopted of recommended production practice (dairy goat farming). Yi is defined as a sequence of dependent binary random variables taking the values of 1or 0, Xi is a K-vector of known explanatory variables, $\beta 0$ is a K-vector of unknown parameters and F is a certain known function.

The functional forms most frequently used in application are linear probability, Probit and Logit models (Amemiya, 1981). The linear probability model has the defect in that F of this model is not properly distributed function, as it is not constrained to lie between 0 and 1. However, the Probit model, like many other models using the normal distribution, may be justified by appealing to a central limit theorem. A major justification for the logit model is that logistic distribution function is similar to a normal distribution function but with a much simpler form. With regard to Probit and Logit models, Amemiya (1981) concluded the difficulty to distinguish them statistically unless one has an extremely large number of observations. The choice between them is largely one of convenience and program availability (Amemiya, 1981; Gujarat, 1995).

For this purpose, one model was analysed using a limited dependent variable regression. Consider the following regression model as described by Maddala (1992):

$$yi^* = \beta 0 + \sum_{j=1}^{k} \beta_j x_{ij} + \mu_i \qquad (1)$$

Where (yi*) is not observed. It is commonly called a 'latent' variable, X's are socioeconomic factors, μi is the error term. However, the latent variable can only be observed as a dichotomous variable (yi) defined by:

$$y = \begin{cases} 1 \text{ if } y^* > 0 \\ 0 \text{ otherwise} \end{cases}$$

Where, (yi) is a variable measuring the adoption/non-adoption of dairy goats. If the cumulative distribution of μi is logistic, we have what is known as Logit model as follows:

$$\log\left(\frac{p_i}{1-p}\right) = \beta_0 + \sum_{j-1}^{k} \beta_j X_{ij} \qquad (2)$$

Where, pi is the probability of adoption. The left-hand side of this equation is called the log-odds ratio, thus the log-odds ratio is a linear function of the explanatory variables. The logit regression gives the option of reporting odd ratios instead of logit regression coefficients. In any case, it's easy to convert one into the other, since odd ratio is logarithmic exponential of regression coefficient (SAS Program, 1998).

The Logit model was used to assess the second and third objectives of this study. It was used to test the following three sets of hypotheses;

H0: Socioeconomic factors have no significant effect on adoption of dairy goats.

H1: Socioeconomic factors have a significant effect on adoption of dairy goats

H0: Availability of dairy goat breeding stock has no significant effect on dairy goat adoption.

H1: Availability of dairy goat breeding stock has a significant effect on dairy goat adoption.

The Logit model used assumes a normal distribution with zero mean and a constant variance. It is specified as follows:-

$$yi = \beta 0 + \beta 1(AGE) + \beta 2(EDU) + \beta 3(GEND) + \beta 4(LAND) + \beta 5(CRED) + \beta 6(NNFARM) + \beta 7(BREED) + \beta 8(EXT) + \beta 9(INFOR) + \beta 10(LABORF) + \beta 11(TLU) + \mu i$$

Where;

yi = log odds of adoption for the ith farmer,

Bo-β11 = parameters of the model,

AGE, EDU..... TLU = explanatory variables described in Table 2, and

μi = error term

To test the significance of the coefficients Z-statistic (standard normal) is used. This is based on the premise that for large samples the t distribution converges to the normal distribution. To test the null hypothesis that all slope coefficients are simultaneously equal to zero the likelihood ratio (LR) statistic is used. The coefficient estimates of the model were interpreted in terms of odd ratios, which are obtained by taking the antilog of the various slope coefficients. Odds ratio is the factor by which the odds change for a unit increase in the corresponding independent variable. The reason for preferring to interpret the results of the Logit regression in terms of odds rather than probabilities is that odds is a pure summary statistic for the partial effect of a given predictor, controlling for the other predictors in the Logit regression (Damaris, 1992).

3.7 A priori Expectation of the model Explanatory Variables

Table 2 shows the a priori assumptions made for the factors influencing adoption of dairy goats whose discussion is made below. The first Column shows the

variable code, second column is the variable name; third column is the measurement unit of the variable and the fourth column is the a priori sign of the variable.

Table 2: Nature and a Priori Expected Signs of Explanatory Variables

Variable code	Variable name	Unit of measurement	Expected sign
AGE	Farmers age	Years	+/-
FAMSIZE	Family members working on farm	Number of persons	+/-
EDU	Years of schooling	Years in formal education	+
LAND	Farm size	Hectares	+/-
CRED	Access to credit	1 if yes, 0 otherwise	+
LSTOCK	Other livestock	Number	+/-
OFFEM	Off farm employment	1 if yes, 0 otherwise	-
EXT	Extension service	Number of visits	+
MKT	Availability of market	Kilometres	+
MEOR	Membership to organization	1 if yes 0 otherwise	+
PERC	Perception	Index	Favourable
PRC	Price of goat milk	Shillings	+
BRD	Availability of breeding stock	1 if yes, 0 otherwise	+
EXP	Farmer experience	Years of dairy farming	+
INFOR	Access to technical information	1 if yes, 0 otherwise	+
GEND	Gender of household head	1 if male, 0 if woman	+/-

Note. 1 Cattle = 1 TLU; 1 goat = 0.15 TLU; 1 donkey = 0.65 TLU (Source: Ramakrishna and Demeke, 2002).

3.7.1 Farmer's age

Farmer's age (AGE) can either generate or erode confidence in new technology. In other words, with more experience, a farmer can become more or less risk averse when judging new technology. Older farmers are more endowed with resources compared to younger farmer which makes them less risk averse. As a result,

age would positively influence adoption; meaning a positive relationship between adoption and age.

Study by Adesina and Zinnah (1993) showed that age positively influences adoption decision. On the other hand, younger farmers have a longer planning horizon and sometimes may have more formal education which would increase their adoption probability; under the circumstance age would negatively influence adoption decision.

3.7.2 Family size

Large households (FAMSIZE) will be able to provide the necessary labour requirement, they have a greater subsistence needs and may mitigate by intensifying on livestock production under situations of scarce land resource. Therefore, family size is hypothesized to positively influence adoption decision. A study by Judicate et al., 1998) found a positive influence of family size to adoption decision.

Under the circumstances that larger families' subsistence needs drain family resource leaving very little for investment into new technologies, family size would negatively influence the decision to adopt. A study by Gamba et al., 1998) found family size to negatively influence adoption. In the current study family size represented individual family members living and working on the farm.

3.7.3 Education

Exposure to education (EDU) should increase a farmer's ability to obtain, process, and use information relevant to the adoption (Nkonya et al., 1997). Education is thus hypothesized to increase the probability that a farmer will adopt dairy goats.

3.7.4 Farm size

Farm size (LAND) is an indicator of wealth and perhaps a proxy for social status and influence within a community. Land size determines the number of enterprises that an individual farmer can have at a given time; farmers with bigger pieces of land can have several enterprises compared to farmers with small pieces. A study by Gamba et al. (1998) found that land size positively influences adoption. However, where land is a constraint, small land sizes could also motivate farmers to adopt enterprises utilizing less land such as keeping of dairy goats. In such a situation,

land would negatively influence adoption. This current study hypothesizes farm size to negatively influence adoption.

3.7.5 Credit

Access to credit (CRED) affects household welfare outcomes through at least two channels. First, it alleviates the capital constraints on agricultural households. Access to credit also reduces the opportunity cost of capital-intensive assets relative to family labour, thus encouraging labour-saving technologies and raising labour productivity (Delgado, 1995; Zeller et al., 1997). Secondly, access to credit affects household welfare by increasing its risk-bearing ability and altering its risk-cooping strategy. The household may therefore be willing to adopt new, more risky technologies (Baidu-Forson, 1999).

3.7.6 Livestock

Ownership of other livestock (LSTOCK) is a proxy for wealth, and wealthier farmers have the means to adopt new technology. Therefore, farmers with higher livestock units are more likely to adopt (Judicate et al., 1998). Bringing on board another livestock activity may present some sort of competition to the already existing livestock enterprises. The farmer may therefore need to compare benefits of the incoming enterprise to the already existing ones in order to make a decision to adopt or not. Therefore, ownership of other livestock is expected to be positively or negatively influence adoption.

3.7.7 Off-farm income

Access to off-farm income (OFFEM) provides farmers an alternative source of income, this can ease liquidity constraint. It can assist the farmer to access and purchase dairy goats. Esardo et al., (2003) reported a positive influence of access to off-farm income to adoption. Off-farm incomes may also influence adoption negatively where returns from off-farm income is higher than returns from farming activities implying that the farmer is better off in engaging in the other activity outside the farm.

3.7.8 Extension

Agricultural extension service provided by the Ministry of Livestock Development (MOLD) is the major source of agricultural information in the study area. Through extension staffs, research findings is disseminated to farmers, the more frequent the extension visits the greater the likelihood of success in the implementation of the new technology (dairy goats). It is hypothesized that contact with extension workers (EXT) will increase a farmer's likelihood of adopting dairy goats. Studies by Judicate et al (1998) and Nkonya et al., (1997) reported a positive influence of access to extension visits to adoption.

3.7.9 Market

This is the availability of goat milk market. It is hypothesized that the availability of ready goat milk market (MKT) will induce farmers to adopting dairy goats. This is expected to be positively related to adoption of dairy goats.

3.7.10 Group Membership

The farmer belonging to a farmer organization indicated as common interest groups, self- help group and/or co-operative. This is a privileged position with respect to other farmers, in terms of his access to information and sharing of experiences with regard to management of dairy goats. It is hypothesized that membership to an organization (MEOR) can be positively related to adoption of dairy goats. A study by Sall et al. (2000) reported a positive influence of adoption decision by the farmer affiliated to farmer organisation.

3.7.11 Gender

Gender differentials are one of the important factors influencing adoption of improved agricultural technologies. Due to long lasted cultural and social grounds in many societies of developing countries, women have less access to household resources and also have less access to institutional services. Regarding the relationship of household's sex with adoption of agricultural technologies, many previous studies have reported that household's gender has a positive effect on adoption in favour of males. For example, Techane (2002), in his study on determinants of fertilizer adoption in Ethiopia found that male headed households are more likely to adopt fertiliser than female headed households.

Farmer's adoption criteria vary greatly between households, depending on the productive resources controlled by the household. However, the criteria also vary within a household. The division of responsibilities and tasks is socially defined according to gender and age. This means that different household members will evaluate a technology according to different criteria, which are related to their roles and functions in the household (Van Veldhuizen., 1997). The role of tending and milking of goats is female oriented and therefore female headed households are more likely to adopt dairy goats than male headed household, therefore a negative influence. On the other hand most resources are owned and controlled by males, in which case male headed households are more likely to adopt dairy goats, therefore a positive influence.

3.7.12 Farmers' Perception

This is the farmer's understanding of what is happening and their forming an opinion or attitude about a given technology. According to Van de Ban and Hawkin (1988), perception is the process by which we receive information or stimuli from our environment and transform it into psychological awareness. The way a farmer perceives a given technology or the attributes of a given technology may influence his/her adoption behaviour. Favourable perception of a given technology might make a farmer have a favourable opinion of that technology and therefore adopt it. The opposite might also be true. In the current study, favourable perception on dairy goats is hypothesized to influence adoption decision positively. Adoption studies investigating influence of perception on adoption include Adesina and Baidu-Forson (1995) and Njane (2007).

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the findings of the study. Initially, sample characteristics are described. The results of the spearman's' rank correlation (rs) and logistic regressions are also presented and discussed.

4.2 Dairy farmers' distribution in Kiambu East district

Table 3 presents the distribution of dairy farmers in the three Divisions of Kiambu East district. Majority of the dairy goat farmers were in Municipality, followed by Kiambaa and Githunguri division in that order and therefore more farmers near Kiambu town were adopters. Municipality is the division hosting Kiambu town which is the district headquarters. The district headquarters inevitably has livestock extension personnel manning the district. Around the town, which is within the municipality, land sizes are small as it has been subdivided into plots for non-farming activities like residential and commercial plots. Kiambaa is farther away from the township while Githunguri is the farthest from Kiambu town. Rogers (1962) reported the importance of distance in adoption and diffusion. To him diffusion is a geographic phenomenon. Farmers around the township are likely to benefit more from the scarce extension services as they can walk to the extension offices to make inquiries. At the same time the extension service providers can also easily visit farmers around them even in cases where government transport is not forthcoming.

According to Diamond (1999), geography sets two barriers to adoption; climatic variability and distance. In this study the distance from Kiambu town had effect on land size and access to extension services. Nearer Kiambu town land was highly fragmented for non-agricultural use and this made the remaining land devoted to farming favourable for intensive farming activities such as dairy goat management. There was inadequate extension service provision in terms of personnel and lack of adequate transport facility in the Ministry of Livestock Development to carry out extension work farther afield. All these favoured those farmers nearer the town because it was possible for them to visit extension officers in their offices when need

arose and could access fresh information on new innovations such as dairy goat farming. As you move away from the municipality towards Githunguri land sizes increases favouring extensive farming such as dairy cattle farming which has greater feed requirement compared to dairy goats. Proximity of the farmer to potential goat milk market within the municipality division might as well have acted as an incentive to dairy goat farming nearer Kiambu town.

Table 3: The distribution of dairy farmers in Kiambu East district, Kenya

Division	[1]Adopter (%)	[2]Non adopter (%)	$\chi 2$
Githunguri	28.13	57.95	9.56
Kiambaa	31.25	25.83	
Municipality	40.63	18.18	

1= adopters are 32; 2= Non adopters are 88

4.3 Quantitative socioeconomic variables of dairy farmers

Table 4 summarizes quantitative socioeconomic variables of the dairy farmers surveyed in Kiambu East district. Table 4a shows that adopters and non-adopters were not significantly different with respect to age, years of schooling, experience in dairy farming, frequency of extension visits and number of family members working on the farm.

Table 4: Quantitative socioeconomic variables of dairy farmers in Kiambu East district, Kenya

Characteristic	Adopters n=32	Non-adopters n=88	Combined means n=120	P-value	t-statistic
Age	47.84 1(14.66)	52.21 (13.12)	51.05 (13.62)	0.120	1.56(NS)
Years of schooling	11.44 (3.36)	10.99 (3.12)	11.11 (3.17)	0.497	-.68(NS)
Land size (Ha)	0.195 (0.77)	0.420 (1.93)	0.359 (1.80)	0.000	3.88***
Years of dairy farming	18.09 (13.15)	21.16 (11.92)	20.34 (12.28)	0.228	1.21(NS)
Extension visits (2009)	0.94 (1.34)	0.58 (1.42)	0.68 (1.41)	0.220	-1.23(NS)
2Family	2.97 (1.12)	3.01 (1.13)	3.00 (1.12)	0.855	0.18(NS)
Tropical Livestock units	1.65 (1.74)	4.07 (2.37)	3.42 (2.46)	0.000	5.28***
Perception Index	43.75 (1.83)	18.75 (4.31)	25.42 (11.73)	0.000	-31.73***

NS= not significant; *** statistically significant at $p < 0.01$ level

Note: 1Figures in parentheses are standard errors.

2 Family is number of family members working on the farm.

The average landholding by household heads in Kiambu East district was 0.359 Ha. Adopters owned less land than non-adopters (Table 4). This variable was significantly different ($p< 0.01$) between adopters and non-adopters. The results suggest that dairy farmers with smaller pieces of land found dairy goats suitable for their kind of farms. None of the adopters rented land and their goats were kept either under full zero grazing or semi-zero grazing management systems. Olmstead and Rhodes (1993), reviewed historical documents that showed that in many cases, much smaller farms adopted some of the new machinery because farmers cooperated and

jointly purchased harvesting equipment. In the case of dairy goats' farmers, they cooperate in sourcing of dairy goats in faraway districts and also in dairy goats' multiplication.

The overall mean tropical livestock units (TLU) for dairy farmers in Kiambu East district was 3.42 units (Table 4), majority of farmers kept dairy cattle, dairy goats and local goats. The mean for adopters was less compared to non-adopters. This variable was significantly different ($p< 0.01$) between adopters and non-adopters with a p-value (0.000) less than α (0.01). The higher mean for non-adopters is attributed to the fact that they kept both dairy cattle and local goats, and dairy cattle had a higher tropical livestock unit (TLU=1) compared to either breeds of goats (0.15 units). Where local goats were kept, some farmers improved them using exotic bucks. In this respect, the farmers would be members of a common interest group where they would jointly buy an exotic dairy buck to serve their local goats.

The overall mean perception index was 25.42 for the household heads in Kiambu East district which was an unfavourable perception of dairy goats (Table 4). This variable was significantly different ($p< 0.01$) between adopters and non-adopters with a p-value (0.000) less than α (0.01). However, adopters had a higher mean compared to non-adopters. This suggests that adopters perceived dairy goats more favourably compared to non-adopters.

4.4 Qualitative Socioeconomic variables of Dairy Farmers

Results of qualitative socioeconomic characteristics of household head are presented in Table 5. Results indicate that adopters and non-adopters were not significantly different with respect to gender of household head and access to off-farm income.

Table 5: Qualitative socioeconomic variables of the farmers in Kiambu East district, Kenya

Variable	[1]Adopters % farmers	[2]Non-adopters % farmers	P-value	$\chi 2$
Male headed household	78.13	82.95	0.480	0.37(NS)
Household accessing credit	81.25	55.68	0.000	12.89***
Household affiliated to farmer organisation	100	81.82	0.010	6.71***
Household accessing off farm income	53.13	63.64	0.297	1.09(NS)
Household accessing dairy goat breeds	96.88	57.95	0.001	11.27***
Household accessing dairy goat information	96.88	56.82	0.000	17.16***

1Adopters= 32; 2 Non- adopter =88; NS= not significant, *** statistically significant at the $p < 0.01$ level.

There was significant difference ($p<0.01$) between adopters and non-adopters with regard to membership to farmer organisations (Table 5) with a p-value (0.01) equal to α (0.01). All adopters belonged to farmer organisations and the active farmer organisations in Kiambu East district were cooperative societies and common interest groups (CIGs). The study found that every dairy goat farmer belonged to a common interest group, a cooperative society or both. This was due to the fact that dairy goat farmers communally rear one breeding buck supplied by Dairy Goat Association of

Kenya (DGAK). The buck is kept by one of the group member on behalf of the others; the custodian farmer receives a monthly contribution Kshs. 50 from each member. Members have access to the breeding buck when their does come on heat, and the buck remains with the particular group for eighteen (18) months after which DGAK exchanges for another one not previously used by the group. Members of these common interest groups are registered with DGAK and maintain good breeding records of their dairy goats.

The aim of DGAK registration is to maintain improved genetic potential of dairy goats and prevent inbreeding. Where a farmer belonged to a cooperative society and common interest group, the study found that, he/ she was in the cooperative society mainly to market his/her cow milk and in the common interest group to access dairy goat breeding services.

There were significantly ($p<0.01$) more adopters who readily accessed dairy goat breeding stock compared to non-adopters (Table 5) with a p-value (0.001) less than α (0.01). Breeding stocks were obtained from the following districts; Muranga, Nyeri, Meru, Thika, Naivasha and a few were bought from neighbours. Availability of breeding stock was crucial to adoption. The difficulty of sourcing breeding stock away from the farmer and the associated costs might have discouraged non adopters from keeping dairy goats.

There were significantly more adopters that had received information on dairy goats compared to non-adopters (Table 5) .This was significant at $p<0.01$ having a p-value (0.000) less than α (0.01). The results suggest that adopters had good networks of information to enable them source dairy goat information from the various sources. During the course of the study it was established that general information was mainly received from Dairy Goat association of Kenya (DGAK), FM radios, agricultural shows and livestock extension staff. The information from DGAK officials and extension agent came inform of training on husbandry and nutrition of dairy goats. The respondents indicated that they felt the need to learn about dairy goats and approached extension agents to be trained within their groups. This is in response to scarce extension service which has evolved into a demand driven service.

There were significantly more adopters that had access to credit compared to non-adopters (Table 5) .This was significant at $p<0.01$ with a p-value (0.000) less than α (0.01). This suggests that adopters had a better access to credit because of their affiliation to farmer groups which lenders prefer when lending to small scale businesses due to the security provided by jointly owned assets by the group.

4.5 Constraints to Dairy Goat Farming

Table 6 presents constraints to dairy goat farming in Kiambu East district. In the order of priority farmers ranked factors were; lack of breeding stock; lack of technical information; lack of capital; high input costs; lack of goat milk market; lack of credit and dairy goat diseases.

Table 6: Constraints to dairy goat farming in Kiambu East district, Kenya

Constraint	Percent of farmers
Lack of breeding stock	35
Lack of technical information	26.67
Lack of capital	23.33
High input costs	21.67
Lack of goat milk market	19.33
Lack of credit	13.33
Dairy goat diseases	5.0

From the survey dairy farmers' ranked lack of breeding stock as the most important constraint to dairy goat farming (Table 6). Dairy farmers in Kiambu East district have to contend with breeding females procured from Meru, Nyeri, Muranga and Thika districts. Matters are not only complicated by the long distances but, also by the logistics of identifying a willing seller. They also complained that the cost of dairy goat is too high (Kshs. 12,000 for a mature doe and Kshs. 9,000 for a weaner female).

Lack of technical information was ranked second in order of importance (Table 6). Dairy farmers view dairy goats as delicate animals that are prone to diseases and therefore a risky venture when the necessary backup technical information is not available. The link between research and the farmer is the extension agent however; farmers' laments that there are few officers are not able to serve them adequately. DGAK supports dairy goat farmers through training but they must of necessity be members of an existing dairy goat group therefore, individuals who are not members of dairy goat groups are disadvantaged. According to World Bank (2001) if farmers become aware of technologies that are relevant to their circumstances and can improve their farm production and thus their welfare, they will most likely adopt these technologies.

Lack of capital was ranked third in terms of importance (Table 6). The cost of a weaned female goat ranges between Kshs. 9,000 and Kshs. 12,000 and yet the animals have to be sourced from far districts bringing in issues of transport cost thereby raising the costs even further. Most dairy goats are managed under zero grazing systems and farmers need to put up housing structures adding to the overall cost. Farmers argue that they lack the start-up capital necessary to engage in dairy goat farming.

High input costs were ranked fourth (Table 6). Essentially the inputs required for dairy goats are quite similar to the ones used for dairy cattle. The animals need to be supplemented well with feeds if the farmer desires to obtain reasonable amounts of milk from them. They require housing structures that are free from draught to avoid disease incidences especially pneumonia, cost of construction materials swells up the production costs. Both external and internal parasites needs to be controlled and the costs of dewormers' raises up the production cost even further.

Lack of product market was fifth important (Table 6). Farmers complained that they could not find market for their milk. However, the problem could not be lack of market as such but rather the levels of milk production. The amounts produced is little as evidenced by the average of 3 litre per day from a Toggenbergs; 2 litres per day from both German alphine and saanen breeds and 1 litre per day from crosses of exotic and indigenous goats. Most dairy goat farmers either used their dairy goat milk for domestic consumption or sold it locally to their neighbours. The average milk

price ranged between Kshs. 60 per litre for neighbours to Kshs. 160 per litre for milk sold Kiambu town. An equal volume of cow milk could fetch kshs. 18.

Lack of credit was sixth important (Table 6). Farmers observed that credit was not easily available to them. First, lending institutions are not enthusiastic to lend credit to farmers because of the risks involved. Most of the farming activities are dependent on nature especially with regard to rains required to produce fodder; therefore lenders fear the risks of losing their money in the event of rain failure. Secondly, lending institutions shied away from lending to dairy goat farmers because they feared losses that would emanate from the death of goats as a result of poor management practices. Matters are complicated further by lending conditions where farmers are required to provide collateral in form of a land title deed yet most land in the district is family owned with the title deed being in the custody of one family member; mostly the original allotee of the land.

Goat diseases were ranked seventh and farmers identified pneumonia as the single most challenging disease in dairy goat management (Table 6). This is normally apparent during cold months of the year (March-May and July-September) and the most vulnerable are kids. This calls for proper housing for dairy goats which translates into high cost of production.

4.6 Correlation between Farmer Perception of dairy goats and Adoption

Spearman's coefficient of Rank correlation (r_s) generated from the STATA output, revealed that there is a positive correlation between farmer perception of dairy goats and adoption was 0.7697 and significant at $p<0.01$ probability level. Therefore, the null hypothesis was rejected and the alternative was accepted. Hence we conclude that there is a positive correlation between farmer perception of dairy goats and their adoption. These results are not surprising even though the overall perception index indicated an unfavourable perception of dairy goats by dairy farmers. This was due to a strong favourable perception of dairy goats by dairy goat farmers.

This result is consistent with the findings of Adesina and Zinnah (1993) and Adesina and Baidu-Forson (1995) which found farmer's perception of technology specific attributes to be positive and significant in influencing adoption decision.

4.7 Factors Influencing Adoption of Dairy Goats in Kiambu East District

Table 7 shows the results of factors influencing adoption of dairy goats in Kiambu east district. The Log likelihood statistic for the logit estimation (30.695) which is greater than the critical value of 21.666 suggests that together the variables have a significant impact on adoption of dairy goats (Table 7).

The results of Logit regression model shows that variables age of household head, gender, none farm income, the number of extension visits per year and the total number of family members working on the farm did not significantly influence adoption of dairy goats.

The results also shows that the P-value of land is 0.051 which is less than α of 0.1 suggesting that land is significant at $p< 0.1$. The odds ratio of 0.425 indicates that a one hectare increase in landholding would reduce the odds in favour of adoption by 57% other things remaining the same. This implies that as land holding decreases dairy farmers are more likely to engage in dairy goat farming. This is indeed is in line with the a priori expectation. Farmers with smaller pieces of land will find dairy goats with their low feed requirements favourable for their farms. This observation is in agreement with Abdul et al. (1993) who reported a significant relationship between landholding (farm size) and adoption.

Household head access to credit had a P-value of 0.008 which is less than α of 0.01 implying that credit is significant at $p< 0.01$. This suggests that credit influenced adoption of dairy goats and therefore the null hypothesis (H0) stating that socioeconomic factors have no significant effect on adoption of dairy goats can be rejected and the alternative (H1) accepted.

Table 7: Logit Regression Analysis of factors influencing adoption of dairy goats in Kiambu East district, Kenya (Adoption as Dependent Variable)

Variable	Odd ratios	Z	p-value
Gender of household head	0.879	-1.95	0.887
	(0.796)		
Age of household head	0.959	-0.14	0.121
	(0.026)		
Years of formal education	0.982	-0.14	0.887
	(0.127)		
Land	0.425	-1.95	0.051***
	(0.187)		
None farm income	0.373	-1.32	0.186
	(0.278)		
No. of extension visits per year	1.33	0.91	0.363
	(0.422)		
Tropical livestock units	0.511	-2.86	0.004*
	(0.120)		
Family labour	0.912	-0.27	0.790
	(0.314)		
Credit	8.197	2.64	0.008*
	(6.527)		
Technical information	13.829	2.17	0.030**
	(16.71)		
Breeding stock	4.678	1.73	0.084***
	(4.181)		

R2=0.5589, LR chi2 (9) = 30.695, $p < \chi 2 = 0.000$. Note; NS= not significant,* p= 0.1, ** p = 0.05, *** p=0.01; Figures in parentheses are standard errors.

The odds ratio for access to credit was 8.197, implying that farmers who had access to credit were 8 times more likely to adopt dairy goat farming compared to those not accessing credit, other things equal. This result is in agreement with the a priori expectation. Credit is essential in relaxing the farmer financial constraints and enabling farmers to finance acquisition of breeding stock, construction of housing structures and purchase of other inputs.

This result is consistent with the findings by Matuschke et al., (2007). Credit provision to dairy farmers' is usually a very complex issue having difficulties in the decision on the amounts and the form of credit, the interest charged, targeting of specific farmers' groups and specific activities and repayment schemes (Ahmed and Ehui, 2000). Most formal credit institutions are reluctant to provide loans to dairy farmers because they often don't have good sureties and are susceptible to epidemics which could lead to inability to pay debts.

The P-value for availability of breeding stock was 0.084 which is less than α of 0.1, implying that availability of breeding stock is significant at $p< 0.1$ level. This suggests that availability to breeding stock influenced adoption of dairy goats and therefore the null hypothesis (H0) stating that availability of breeding stock does not affect adoption of dairy goats is rejected and the alternative (H1) is accepted. The odds in favour of adoption for dairy farmers who accessed breeding stock were 4.678. The result implies that, farmers who could access dairy goat stock were approximately 5 times more likely to adopt them compared to those without access to them, other things remaining the same.

This is not surprising because access to breeding stock in terms of availability of the animals and the animals being affordable would enable interested farmers buy their stock. FAO (1996) reported that to improve agricultural production, some form of appropriate technology is necessary. Appropriate technology in this context is defined as; the latest technological development that has been adjusted to suit the local conditions to the highest possible degree. In the present study appropriate technology is the exotic/cross bred dairy goats.

Most significant at $P< 0.01$ probability level was tropical livestock units (TLU). The p-value for this variable was 0.004 which is less than α of 0.01. The odds ratio for this variable was 0.51, implying that increasing TLU by one unit would reduce odds in favour of adoption by 49% other things remaining the same. Dairy goat farming being a livestock activity will compete for similar farm resources such as labour, feeds and space for housing on the farm with the other livestock enterprises.

Therefore, it is not surprising that having additional livestock on the farm will reduce resources devoted to dairy goats. The results are in line with the a priori.

However, the results contradict earlier crop related adoption studies by Judicate et al., (1998). Livestock in crop enterprise will complement crop enterprise; income from livestock could be used to purchase inputs for the crop enterprise and therefore influence adoption positively.

The P-value for the availability of technical information was 0.030. This is less than α of 0.05 implying that availability of technical information is significant at $p< 0.05$. This suggests that availability of technical information influenced adoption of dairy goats, therefore the null hypothesis (H0) farmers' socioeconomic factors of dairy goats has no significant effect on dairy goat adoption was rejected and the alternative (H1) accepted. The odds ratio of 13.829 for this variable implies that farmers with access to technical information on goat management were approximately 14 times more likely to adopt dairy goat farming compared to those without access to technical information other things remaining the same.

This is not surprising because dairy goats being exotic are delicate to handle and may require that farmers have some minimum level of training on their management in terms of feeding, housing and disease prevention/control. In the absence of such technical information, farmers would be hesitant to invest in dairy goats. These results are consistent with the findings of Matuschke et al., (2007) on adoption of hybrid wheat in India.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study has shown that adopters of dairy goats had more years of formal education, slightly younger, had less family members working on the farm, owned smaller farms and had fewer years of dairy farming experience. They also had lower TLU, were all members of farmer organisation and had greater access to credit.

The study has also shown that significantly more adopters had information on dairy goat and were trained on their management and had access to dairy goat breeding stock. More adopters had access to credit compared to non-adopters. The average number of extension visits per year did not significantly differ between adopters and non-adopter.

Farmers ranked in the order of importance the following factors as most limiting to dairy goat farming:

- Lack of breeding stock
- Lack of technical information
- Lack of capital
- High input costs
- Lack of goat milk market
- Lack of credit
- Dairy goat diseases

The Spearman's coefficient of rank correlation showed that indeed there was a high and positive correlation between farmers' perception of dairy goats and their adoption. The Logit analysis showed that dairy goat adoption was influenced by:

- Availability of breeding stock,
- Other livestock (TLU) kept by farmers other than dairy goats,

- Access to credit,
- Land and
- Availability of technical information.

5.2 Recommendations

The results of this study have implications for everyone concerned with the improvement of adoption of dairy goats in Kiambu East district. To supplement diminishing public extension service, facilitation on formal education expansion should be given priority for future improvement of technology adoption. Livestock related courses specifically on dairy goat rearing in secondary schools and post-secondary institutions could yield the desired results.

Credit could be made available to farmers to build up the capital required in starting up dairy goat enterprise. This could be done by minimizing stringent lender condition to borrower by lending institutions. The livestock banks would be tried by Non-governmental organisations, where a group of farmers would be loaned dairy goats and they would repay the loan in kind by way of surrendering their first dairy goat offspring to the group. This offspring can be loaned to other group members with similar repayment arrangements.

Farmer groups need to be strengthened as means of information gathering, production and marketing. This would go a long way in helping dairy goat farmers' source for best breeds and obtain the best market prices for their inputs and products.

The idea of raising a common breeding buck for members of farmer groups is not only cumbersome but sometimes may be costly because of the danger of transmission of breeding diseases. Policy maker and development agencies need to look at the possibility of providing an affordable AI scheme to dairy goat farmers.

In order to make marketing sense there is need to enhance productivity of the dairy goat. Therefore in order to achieve this, policy makers need to look at institutional support for research by animal scientists on the improvement of dairy goats.

REFERENCES

Abdul, R. Q, Asfaq, H. M. and Sultan, A.C. (1993). Farmers Characteristics affecting Adoption of Agricultural Innovations. Journal of Rural Development and Administration. Vol 25(3):111-113

Adesina, A. A, and Baidu-Forson J (1995) Farmer Perception and Adoption of New Agricultural Technology: Evidence from Analysis in Bukina Faso and Guinea, West Africa Agricultural Economics13 (1995) 1-9.

Adesina, A. A, and Zinnah, M. (1992). Adoption, diffusion, and economic impacts of modern mangrove rice varieties in western Africa: Further results from Guinea and Sierra Leone. In Towards a New Paradigm for Farming System Research/Extension. Working Paper for the 12th Annual Farming System Symposium. East Lansing: Michigan State University. USA

Adesina A. A. and Zinnah, M. M. (1993). "Technology Characteristics, Perception Adoption Decisions: A Tobit Model Application in Sierra Leone". Agricultural Economics. 9, 297-311.

Ahmed M. M. and Ehui S. (2000). Credit Policy and Intensification in Mixed crop-livestock Systems: A Modelling Perspective. Summary of Papers and Proceedings of a Seminar held at ILRI, Addis Ababa, Ethiopia, Socio-economics and Policy ResearchWorkingPaper30.68pp http://www.ilri.org/inforserv/webpub/fulldocs/workp Accessed 1st/July/2010.

Ahuya, C. O, (2007) Proceedings of the 6th Eastern Africa Goat Development Network (EAGODEN) Biennial Conference. Mt. Elgon Hotel, Mbale, Uganda

Ali M. (1995), Institutional and socio-economic constraints on the second-generation green revolution: a case study of rice producers in Pakistan's Punjab. Econ. Dev. Cult. Change, 43(3), 835-861.

Al-karablieh, E. and Salem M. (1999). Measuring the Bias of New Production Technologies of Barley in Jordan. Disarat, Agricultural Sciences, 26 (1): 106-113

Amemiya, T. (1981). Qualitative response models: a survey. Journal of Economic Literature, 19(4): 1483-1536

Baidu-Forson J (1999). "Factors Influencing Adoption of Land-enhancing Technology in the Sahel: Lessons from a Case Study in Niger". Agric. Econ., 20: 231-239.

Baltenweck , I. and S.J. Staal, (2000). Determinants of Adoption of Dairy Cattle Technology in the Kenyan Highlands; A spatial and Dynamic Barham, Approach, contributed paper submission, IAAE meetings, Berlin, August 2000.

Boahene, K., Snijder, T. A. B. and Folmer, H. (1999). An Intergrated Socioeconomic Analysis of Innovation adoption: The Case of Hybrid Cocoa in Ghana. Journal Of Policy Modelling. 21:167-184

Bradford , G. E., Fitzhugh, H. A and Dowding A.(1983). Reproduction and birth weight of Barbados. Blaucbelly sheep in Golden Groove flock, Barbados, In Fitzhugh H.A and Bradford (G.E) Hair sheep in Western Africa and the American pp163- 176, westview press; Boulder, USA.

Bunders, J., Bertus, H. and Wim H. (1996). Biotechnology Building on Farmers' knowledge. Macmillan, London.

Caswell, M., K. Fuglie, C. Ingram, S. Jans and C. Kaslak (2001). Adoption of Agricultural Production Practices: Lessons Learned from the US. Department of Agriculture Area Studies Project. Washington DC. US Department of Agriculture: Resource Economics Division, Economic Research Service, Agriculture Economic Report No. 792.

CIMMYT. (1988). From Agronomic Data to Farmer Recommendations: An Economics. Training Manual. Mexico, D.F.: CIMMYT

Damaris, A. (1992). Logit Modeling: Practical Applications. International Educational and Professional Publisher, London .

Dasgupta, Satadal, (1989). Diffusion of agricultural Innovations in Village India. Wiley Eastern Limited, New Delhi. Pp231.

Diamond, J., (1999). Guns, Germs and Steel (W.W. Norton and Company, New York).

Delgado C. L, Rosegrant M .W., Steinfeld H., Ehui S. and Courbois C. (1999) Livestock to 2020: The Next Food Revolution. 2020 Vision for Food, Agriculture, and the Environment. Discussion paper No. 28. Washington D.C.: International Food policyresearch Institute/ orftp://ftp.fao.org/docrep/nonfao/lead/x6155e/x6155e00.pdf (Accessed on 21st January 2009).

Delgado C. (1995). Africa's Changing Agricultural Development Strategies: Past and Present Paradigms as a Guide to the Future. 2020 Vision Food, Agriculture, and the Environment Discussion Paper 3. Washington, D.C.: International Food Policy Research Institute.

Devendra, C., Burns M., (1983). Goat production in the tropics. Common Wealth Agriculture Bureaux, Franham Royal UK. Pp183.

Ellis, F. (2000), Rural Livelihood and Diversity in Developing Countries, Oxford: Oxford University Press

Emad, K. A., Ahmad, S. H., Doukhi, A. H. (2009). Logit Model for Identifying Factors that Influence the Adoption of Barley Production Technologies in Low Rainfall Areas. Jordan Journal of Agricultural science, Volume5, No.3

Esardo, L., Amacher, G., Alwang, J. (2003). "Productivity and Land Enhancing Technologies In Northern Ethiopia: Health, Public, Investment and sequential Adoption" In Proceedings of the 25th International Conference of Agricultural Economics. Durban South Africa. 16th -22nd August. 682-692.

Feder, G., R.E. Just, and Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. Economic Development and Cultural Change Pp 255-297.

Food and Agriculture Organisation (FAO), (1996). Food for All Report of the World. Food Summit 13-17 Nov. 1996.pp32-39 (1996).

Food and Agriculture Organisation (FAO), (2005). Livestock brief, Kenya pp10.

FAOSTAT (2008) : http//faostat.fa.org/default. Accessed on 4th November 2011

Gamba, P., Ngugi C., Verkuijl, H., Mwangi, W., and Kiriswa, F. (1998). " Wheat Farmers' Seed Management and Varietal Adoption in Kenya". In The Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa. University of Stellenbosch. S.A 14th -18th September. 53-62.

Gebremedhin, B. and M. Swinton (2003). " Investment in Soil Conservation in Northern Ethiopia: The Role of Land Tenure and Public Programs'. Agricultural Economics 29:69-84.

Girja, S .P. and Muliokela, S. W. (2006). Smallholder Dairy Farming: A Tool for HIV/AIDS Mitigation and Food Insecurity. Paper presented in African Forum 2006, LUSAKA-ZAMBIA.

GOK, (Government of Kenya), (2005). National policy for the sustainable development of Arid and semi-arid lands of Kenya. Nairobi: Government Printer, Nairobi.

GOK, (Government of Kenya), (2007). Kiambu East district Livestock Annual Report. (Unpublished).

GOK, (Government of Kenya), (2010). Ministry of Livestock Development Annual Report. (Unpublished).

Greene, W., (2000). Economic Analysis, Prentice Hall, Upper Saddle River, NJ

Griffin, G.R.,D. T. Vere and D.W. Bootle (1995). An Integrated Approach to Assessing the

Farm and Market Level Impacts of New technology Adoption in Australian Lamb Production and Marketing System:Agricultural systems, (47): 175-198

Gujarat, D.N. (1995). Basic Econometrics. 3rd edition. McGraw-Hill, Inc., 568 Hardon-Baars, A. (1997) Users' perspective: Literature review on the development of a Concept. UPWARD Working Paper series No. 4, Los Banos, Laguna.

Holden, S.T. and Shiferaw, B. (1998). Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands; A Case Study in Andit Tid, North Shewa. Agricultural Economics 18: 233-247.

IAASTD (2007). Global Report. Washington DC: International Assessment of Agricultural Science and Technology for Development.

IAC, (2004) Realizing the Promise and Potential of Africa Agric., Amsterdam, pp266 (Inter Academy Council).

Judicate, W., Ahaz, M., Wilfred, M. and Hugo, V. (1998) " Adoption of Improved Wheat Technologies by Small-scale Farmers in Mbeya District of Southern Highlands, Tanzania." In Proceedings of Tenth Regional Wheat workshop for Eastern,, Central and South Africa. University of Stellenbosch, S.A, 14-18 SEPTEMBER , pp39-43.

KNBS (2009). Housing and population Census 2009. Government Printers, Nairobi.

Knox, I., (1998) Dairy Goat, Farm Diversification Information Service, Bendigo

Karki, L.B. (2004). Impact of Project intervention in Rural Household Nepal:Assessment of Socio-economic and Environmental Implication. A PHD thesis submitted to the University of Giessen, Institute of Project and Regional Planning, Giessen, Germany.

Leeuwis, C. and Van den Ban A. (2004). Communication for Rural Innovation: Rethinking Agricultural Extension, (3rd edition) Oxford: Blackwell Science.

Little, D.P. (1984). Critical socio-economic variables in African pastoral livestock Africa development: Toward a comparative framework. In Livestock development in sub-Saharan constraints, prospects, policy(J.R.Simpson &P. Evangelou, ,eds).Westview Press, Boulder, Colorado, 212-213

Maddala, G.S. (1992). Introduction to econometrics, 2nd edition. New York; MacMillan Publishing Company. 323-337

Matuschke, I.R., R.R. Mishra and M. Qaim (2007). Adoption and Impact of Hybrid Wheat in India. World Development, 35(8): 1422-1435

Misra, S.K., D.H. Carely, and S.M. Fletcher. (1993)." Factors influencing southern

dairy farmer's choice of milk handlers". Journal of Agricultural and Applied Economics Pp 197-207.

Mburu, J., Lumumba T. K, Mwai O. (2008), Determinants of transaction costs in group based Breeding approaches: the case of dairy goats in the eastern Kenyan highlands. Discussion paper. (Unpublished)

Mclver, J.P., and Carmines, E.G., (1981). Unidimensional Scaling. Thousand Oaks, CA: Sage.

Morris, M. L. and C. R. Doss. (1999). How does Gender Affect the Adoption of Agricultural Innovation? The Case of Improved Maize Technology in Ghana. Paper presented at the annual meeting of American Agricultural Economics Association (AAEA), Nashville, Tennesse, August 8-11.

Moyo, S., McDermott, J. J., Herrero, M., Van de Steeg, J. A., Staal, S.J. and Baltenweck, I. (2009). Development of Livestock Production systems in Africa. Challenges and Opportunities with a Focus on Recent Achievements. In: Animal Production and Animal Science Worldwide. WAAP book of the Year 2007. World Association for Animal Production. Pp15-26.

Mukras, M.S. (1993). Elementary Econometrics: Theory, application and policy. East African Educational Publishers, Nairobi. Kenya.

Mussei, A., J. Mwanga, W. Mwangi, H. Verkuijl, R. Mongi, and A. Elanga. (2001). Adoption of Improved Wheat Maize and Technologies by Small-Scale Farmers in Mbeya District,Southern Highlands, Tanzania..Mexico,D.F.: International Wheat Improvement Center (CIMMYT) and the United Republic of Tanzania.

Nassiuma, D.K. (2000). Survey Sampling: Theory and Methods. Nairobi: Nairobi University Press.

Nkonya, N., T. Schroeder, and D. Norman (1997). " Factors Affecting Adoption of Improved Seed and Fertilizer in Northern Tanzania". Journal of Agricultural Economics.48 (1):1-2

Njane P. W., (2007). Determinants of Adoption of Improved Wheat Varieties and Fertilizer Use by Smallholder Farmers in Njoro and Kieni West Divisions. MSC Thesis

Nji A. (1993). Constraints to livestock development in the North-West Province of issues Cameroon (West Africa). In Livestock development in developing countries: and Development and research needs. Proc. International Workshop of the Council for

Tropical Subtropical Agricultural Research (J. Richter,K.J. Peters & H. Franzen, eds). Food and Agriculture Development Centre, Feldafing, Germany, 75-99.

Nunnally, J.C., and Berstein, I.H., (1994). Psychometric Theory (3rd ed.). New York: Mcgraw-Hill , pg 67.

Okeyo, A. M., (1997). Challenges in goat improvement in the developing rural economies of Eastern Africa, with special reference to Kenya. In: Ahuya, C.O., Van Houton, H. (Eds.), Goats Development in East Africa. Proceedings of Worksshop Held in Embu, Kenya, 7-11 December 1997. Farm Africa, Kenya, pp. 55-66.

Olmstead, A.L. and RhodesP. (1993). Induced Innovation in American Agriculture: A Reconsideration, Journal of Political Economy 101 (1) 100-108

Peacock, C. P. (1996) Improving Goat Production in the Tropics. A manual for development workers. FARM-Africa/Oxfam, Oxford.

Peacock, C.P (2005) Goats: Unlocking their potential for Africa's farmers. Paper presented at seventh conference of Ministers Responsible for Animal Resources. FARM-AFRICA WORKING SERIES.

Perry, B. D. ,Randolph, T. F., McDermott, J. J., Sones, K.R., Thorton, P.K.(2003). Investing in Animal Health Research to alleviate Poverty. ILRI, Nairobi,Kenya.pp148

Ramakrishna G. and Demeke A., (2002) An empirical analysis of food insecurity in . Ethiopia; The case of North Wello, World Development 27 , pp. 127–143

Rogers, E.M. (1962). Diffusion of innovations (Free Press of Glencoe, New York).

Rogers, E.M. and Shoemaker, F.F. (1971). Communication of Innovation: A Cross-cultural Approach, (2nd ed.). The Free Press, New York.

Rogers, E.M. (1995). Diffusion of innovations (5th ed.). New York: The Free Press.

Sall, S., Norman, D. and Featherstone, A. M. (2000). " Quantative Assessment of Improved Rice Variaties Adoption in Senegal: Farmers' Perspective" Agricultural systems. 66 (2). 129-144

SAS Program, (1998). SAS User's Guide. LOGESTIC Procedure. Cary, NC, USA.

Sarap, K. and D. C. Vashist (1994). Adoption of Modern Varieties of Rice in Orissa: a farm level analysis. Indian Journal of Agricultural Economics, 49: 88-93.

Scarborough. V., (1996). Farmer Led Approaches to Extension. Agriculture Research and Extension Networks, Development Institute, London No. 59

Sheikh, A. D., Rehman and Yates C. M., (2003). Logit models for identifying the factors that influence the up-take of new "no-tillage" by farmers in the rice-wheat and cotton-

wheat farming systems of Pakistan's Punjab. Agricultural Systems, 5(1):79-95.

Sutherland A.J. (1987). Targeting Livestock Research for Zambia's Traditional Sector: The Need for a Socio-economic Input. Paper presented to Zambia's 1st National Conference on livestock development, 5-10 July, Lusaka. School of Veterinary Medicine, University of Zambia, Lusaka, pp10.

Techane A., (2002). Determinants of Fertilizer Adoption in ethiopia. The Case of Major Cereal producing areas. M.Sc. thesis (Unpublished) Presented to School of Graduate Of Alemaya University.

Van de Ban, Hawkins A.W. (1998). Agricultural Extension (2nd ed.) Blackwell Science The Netherlands. Pp249.

Van Veldhuizen, Laurens Van, Ann Waters-Bayer and Henk De Zeeuw (1997) developing Technology with Farmers: A Trainer's Guide for Participatory Learning. Zed Books

Ltd, London. World Bank, 2004. Opportunities and Challenges for Development of High Value Agricultural Exports in Ethopia. The Word Bank Report No 14.

World Bank, (2001). Agricultural Extension and Research Achievements and Problems In National Systems. The World Bank Group.

World Bank, (2009). World Bank Development Indicators. Accessed at http://web.wordbank.org/. Accessed on 15th Feb 2011

Tripathi, B. and Psychas, P. (1992) The AFNETA alley farming training manual-Volume 1: Core course in alley farming, Food and Agriculture Organisation (FAO), Rome.

Van de Ban A.W. and H. S Hawkin (1988). Agricultural Extension. John Willey & Sons, New York, UnitedStates. P. 61-127.

Wetengere, K. K. (2009). Socioeconomic Factors Critical for adoption of Fish Farming Technology: The case of Selected Village in Eastern Tanzania: Int. J. Fish Aqua, 1(3) 028-039.

Wetengere, K. K. (2010). Determinants of adoption of a Recommended Package of Fish Farming Technology: The Case of Selected Villages in Eastern Tanzania. Adv. J. Food sci. Technol., 2 (1):55-62

Wheeler, S. (2005). Factors Influencing Agricultural Professionals Attitudes Towards Organic Agriculture and Biotechnology. Centre for Regulation and Market Analysis, University of Austria.

Winrock International, (1992). Assessment of Animal Agriculture in Sub-Saharan Africa. Winrock International Institute for Agricultural Development, Monilton, Arkansas pp125.

Zeller M, Schrieder G, von Braun J, Heidhues F (1997). Rural Finance for Food Security for the Poor: Implications for Research and Policy. Food Policy Review No. 4. Washington, D.C.: International Food Policy Research Institute.

APPENDIX I: QUESTIONNAIRES

TITLE: FACTORS INFLUENCING ADOPTION OF DAIRY GOAT FARMING IN KIAMBU EAST DISTRICT, KENYA.

Code_____

The purpose of this study is purely academic and above all, to generate knowledge that would be useful to the study. As a respondent you are kindly requested to participate in answering this questionnaire and you are assured that any information shared will be strictly confidential.

QUESTIONNAIRE SERIAL NUMBER----------

DATE OF INTERVIEW----------

NAME OF FARMER----------

DIVISION ----------

SECTION I

Q1. Profile of the farmer

Gender 1=male 2=female	Age (in years)	Number of years in formal education	Level of education 1=Primary 2=Secondary 3=Tertiary 4=Others (specify)	Farmer occupation 1= farmer/civil servant 2= farmer /business 3 = housewife 4=non-fulltime employment 5= others (specify)----------	Household head 1=man 2=woman
[------]	[----]	[----------]	[----]	[----------]	[----------]

Q2. Do you belong to an organization? Yes [_____] No [_____]

Q3. If the answer to Q2 is yes, what type of organization do you belong to?

1= Self-help group [_____]

2= Common interest group [_____], specify.....

3= Co-operative society [_____], specify.....

4= others, specify.....

Q4. Profile of the Farmers land

Tenure system by category		Land allocations		
Category	Units 1=Acres 2=Ha	Fodder	Grazing	Crop
Jointly owned	[___]	[___]	[___]	[___]
Individually owned	[___]	[___]	[___]	[___]
Rented in	[___]	[___]	[___]	[___]
Rented out	[___]	[___]	[___]	[___]
Others specify……..	[___]	[___]	[___]	[___]
Total	[___]	[___]	[___]	[___]

Q5. State your credit position

Credit	**Credit type**	**Credit source**	**Reasons for no credit**
1=yes 2=no	1=money 2=input 3=dairy goat 4=others, specify……	1=bank 2=microfinance 3=relative 4=neighbour 5=government 6=NGO 7=others, specify……..	1=no collateral 2=high cost of credit 3=stringent loan condition 4=no lender nearby 5= others, specify…….
[___]	[___]	[___]	[_____]

Q6. Did you have any other source of cash outside farming during the 2008 farming year?

1= Yes [_____] 2= No [_____]

Q7. If your answer is Yes to Q6, specify the source as below:-

1=Interest from saving/share investment [_____]

2=Remittance from employed children and other relatives [_____]

3=Business owned [_____]

4=Others (specify).....

Q8. Did you keep dairy goats during the 2008 farming year?

1= Yes [_____] 2= No [_____]

Q9. Id your answer to Q8 is No, give reasons

1=Breeding stock not available [_____]

2=They are expensive to buy [_____]

3=Have never heard about them [_____]

4=Others (Specify) .....

Q10. Provide information relating to dairy goats.

Breed	Source of the Breed and Number 1= NGO 2=neighbour 3=dowry 4=others (specify)		Initial source of information 1=extension 2=agricultural shows 3=research centre 4=field days 5= radio 6=others, specify……	Management system 1=Zero grazing 2=open grazing 3=semi Zero grazing
	Source	Number		
Toggenberg	[ ]	[ ]		
German Alpine	[ ]	[ ]		
Saanen	[ ]	[ ]		
Anglo Nubian	[ ]	[ ]		
Crosses (specify)…..				
	[ ]	[ ]	[ ]	[ ]

Q11. State reasons for keeping dairy goats (Tick appropriately)

1= Cash resource [ ]

2= Financial security [ ]

3= Home milk consumption [_____]

4=Leisure [_____]

5=Others specify .....

Q12. To what extent has dairy goat breeding stock been available to you? (Tick appropriately)

1= Always available [_____]

2= Sometimes available [_____]

3= Rarely available [_____]

4= Never available [_____]

Q13. How long have you been keeping dairy animals (goats/cattle)? .....years

Q14. Did an extension officer visit you in 2008? Yes [____], No [____].

Q15. If your answer to Q10 is yes, how many times? [____]

Q16. Have any of your family members been trained on dairy goat management?

Yes [____], No [____]

Q17. If your answer to Q16 is **Yes**, who was trained?

1=Husband [_____]

2=Wife [_____]

3=Son [_____]

4=Daughter [____]

Q18. What aspect of goat management was he/she trained on? .....

Q19. Provide information regarding goat milk market

Outlet	Amount sold/per day (litres)	Distance to the marked village 1=Same 2=<5km,3=5-10km, 4=>00km	Price/litre (Kshs)
Neighbour	[ ]	[ ]	[ ]
Hospital	[ ]	[ ]	[ ]
co-operative society	[ ]	[ ]	[ ]
Others specify.....	[ ]	[ ]	[ ]

Q20. Rate your goat milk market reliability, 1=very reliable, 2=reliable, 3=sometimes reliable, and 4=unreliable [ ]

Q21. If reliable, do you wish to increase on milk production by increasing your herd size?

1 =Yes [ ] 2= No [ ]

Q22. Provide information relating to input market

Input	Type of input bought	Supply source 1=local duka 2=agrovet shop 3=co-operative outlet 4= others, specify	Distance from the source 1=<5km 2=5-10km 3=>10km	Transport cost (Kshs)	Reasons for no inputs
1=yes 2=no	Feed	[___]	[___]	[___]	1=Expensive 2=Not accessible 3=No information about them 4=Others specify .....
	mineral supplement	[___]	[___]	[___]	
	Dewormers	[___]	[___]	[___]	
	Acaricides	[___]	[___]	[___]	
	Others specify.....	[___]	[___]	[___]	
[___]					[___]

Q.23. To what extent has dairy goat inputs been available to you? (Tick appropriately)

1= Always available [_____]

2=Sometimes available [_____]

3=Rarely available [_____]

4=Never available [_____]

Q24. Provide information on family labour

Family members working on farm by age	Number of persons	Quantity of labour(man-days)/person	Total labour(man-days)
18-35years	[_____]	[_____]	[_____]
36-53years	[_____]	[_____]	[_____]
54-71years	[_____]	[_____]	[_____]
>72years	[_____]	[_____]	[_____]

Q25. What do you consider as the FIVE primary limiting factors to farmer's ability to engage in dairy goat farming (tick where appropriate)

1=lack of breeding stock	9=lack of reliable market
2=lack of technical information	10 =poor access to transportation means
3=goat diseases	11 = lack of market information
4=inadequate start-up capital	12= long distance markets
5=poor access to credit	13= Others (specify)
6=low goat milk price	
7=high input cost	
8=lack of inputs	

Q26. Rank the factors listed in Q25 in the order of their importance (1 being the most constraining, 5 the least constraining)

Rank 1= [____]

Rank 2= [____]

Rank 3= [____]

Rank 4= [____]

Rank 5= [____]

SECTION II

Q27. The following questions will be used to measure farmer's perception of dairy goats. Please answer all questions by ticking appropriately and scaling them i.e. strongly agree is given a scale of 5, agree 4, uncertain 3, disagree 2 and strongly disagree 1.

1. Dairy goat farming is consistent with farming objectives

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

2. Dairy goat farming is a profitable enterprise.

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

3. Dairy goats can increase farm income and therefore improve one's livelihood

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

4. Dairy goat farming can be tried on a small area without interfering with other livestock activity

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

5. Dairy goat farming presents a complex task to implement in livestock production

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

6. Dairy goat breeding stock is readily available and affordable

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

7. Dairy goat inputs are readily available and affordable

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

8. Dairy goat inputs are affordable

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

9. Dairy goat product market is readily available and reliable

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

10. Dairy goats are easier to maintain on the farm

Strongly agree [____]

Agree [____]

Uncertain [____]

Disagree [____]

Strongly disagree [____]

APPENDIX II: STATA COMPUTER OUTPUT

logistic regression Number of obs = 120

LR chi2(11) = 77.79

Prob > chi2 = 0.0000

Log likelihood = 30.694881 Pseudo R2 = 0.5589

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dg2008	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	.9589803	.0259159	-1.55	0.121	.9095079	1.011144
edu	.981798	.127543	-0.14	0.888	.7611051	1.266484
hh	.8791897	.7959227	-0.14	0.887	.1491067	5.184034
land	.424723	.1866893	-1.95	0.051	.1794549	1.005208
cred	8.197739	6.527317	2.64	0.008	1.721626	39.03458
nnfarmin	.3738436	.2779962	-1.32	0.186	.0870407	1.605674
breedst	4.678467	4.180968	1.73	0.084	.8117403	26.96435
frequncy	1.333621	.4218748	0.91	0.363	.7174061	2.479132
training	13.82907	16.70515	2.17	0.030	1.295879	147.578
qntlab	.9125155	.3139078	-0.27	0.790	.4649696	1.790836
tlu	.5108651	.1199274	-2.86	0.004	.3224658	.8093358
