Analysis of Socio-economic Factors Influencing the Adoption of Breeding Technologies among Dairy Farmers in the North Rift Region of Kenya

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Abstract:

In many third world countries today, Kenya included, adoption of agricultural technologies plays a big role in agricultural production especially due to the need to increase production for food security and income. North Rift is one of the regions in Kenya where the dairy sub-sector is the second largest income contributor. This sector employs 50% of agricultural labour force and provides substantial amount of raw materials for local meat and milk processing industries. Though the region is one of the high potential agricultural areas in Kenya, the total annual milk output lately does not match the region's potential. North Rift region is endowed with a lot of livestock and thus is expected that dairy output in the region should be high yet this is not so. Despite the government's plans to develop the livestock sector through the introduction of various technologies such as breeding the local farmers hardly implement this technology. This has resulted in low milk production in the region. This study therefore, sought to determine and analyze the socio-economic factors that affect the adoption of breeding technologies among the dairy farmers in the region. The study was undertaken in Nandi, Uasin-Gishu and Trans-Nzoia counties of the North Rift region. A survey research design was used. The target population was all dairy farmers in the three counties of the region. Purposive, multistage, simple random and systematic sampling techniques were used to get 360 respondents for the study. Data was collected by use of structured questionnaires and analyzed using descriptive and inferential statistics. Dairy farming households were used as units for analysis. Descriptive analysis and the Logit model were used to analyze data in order to answer the study objectives. The results showed that the age, gender and education level of the farmer, size of dairy land, cost of AI and frequency of visits by the extension personnel significantly influenced the adoption of breeding technologies by the farmers. There is need for the government to revive and expand adult literacy classes to enhance level of education of farmers and hence adoption of technology. The results also showed that the cost of the selected technology was the biggest predictor of changes in odds ratios and also had high marginal effects. The government should therefore introduce cost sharing programmes on AI services; employ more extension personnel and improve their mobility through provision of means of transport so as to enhance access to information by farmers. It is also recommended that land fragmentation be discouraged. Policies geared at improving education system, empowering women, strengthening extension services, appropriate land policy reforms and providing financial support to farmers will help a lot in promoting adoption of breeding dairy technologies in the North Rift region.

KEY WORDS: North Rift region, Dairy Farmers, breeding technology, Innovations, Household, Adoption, Food security, livestock productivity.

1.1Introduction: Dairy development in developing countries has played a major role in increasing milk production, improving income level in rural areas, generating employment opportunities and improving the nutritional standards of the people, especially for small scale farmers. Low and unreliable income from cash crops suggest that alternative farming activities should be developed. This is in spite of indications that there is a potential for dairy development to reduce the level of poverty. However, smallholder dairy production is becoming increasingly important and contributes magnificently to the improvement of the livelihoods of rural people. Higher level of technology adoption is associated with better milk yield and improved dairying has a direct impact on income generation, poverty alleviation and availability of animal protein. Thus, to increase the milk production, existing dairy technology should be adopted in the small holder dairy farms.

Dairying is growing faster in such countries as Bangladesh but facing the problems of inefficient management practices and health care, lack of high quality breeds, lack of proper

breeding programme to improve the existing dairy cattle resource, high input and low output prices leading to lower productivity (Uddin *et al.,* 2010).
. Understanding the factors affecting farmers' adoption of dairy technology is critical to success of development and implementation of policies and programmes in dairy industry development

Food output in Africa lags behind the rest of the world's production levels. In the last decade, the continent's share of world food production was a meager 3.9%. By comparison, Asia, North America and Europe produced 47.7%, 14.8% and 12.2% respectively (Oerke, *et al.,,* 1994). By 1990, Africa's population was 615 million and was projected to increase to 813 million by the end of 2002 (FAOSTAT, 2002), a 32% population increase in just over a decade. Moreover, even within Africa, there are variations in these trends with some countries exhibiting higher population growth with low agricultural development. Sub-Saharan Africa's agricultural performance has been variably called the world's foremost global challenge (United Nations, 1997) and referred to as "still very far behind" the rest of Africa (Odulaja and Kiros, 1996 p.86). Moreover, the region's population is increasing, and was expected to account for 30% of the underdeveloped world by the year 2010.

According to FAO, sub-Saharan Africa was expected to have 264 million chronically undernourished people by the year 2010 (FAO, 1996). Several demographers have studied the situation and hypothesized numerous ways of avoiding the 'Malthusian trap' that is likely to envelop the Continent. IFPRI suggests that the supply of food will need to rise by around 70% by the year 2020 if the 6.5 billion people who are expected to be living in developing countries, including Kenya, are going to be food secure (Leisinger, 1996). With only 3 years to this deadline, food production has remained stagnant, or declined in most of sub-Saharan Africa. IFPRI already realized that food problems in sub-Saharan Africa will persist well beyond 2025 (McCalla, 1999). One sure way of mitigating against food insecurity is adoption of modern agricultural technologies.

In dairy production in 5 states in the US for instance, El-Osta and Morehart (1999) identified age of operator, size of operation and specialization as important factors in increasing livelihood, while research by Caswell *et al.* (2001) ascertained that high levels of farm operator education were likely to induce adoption and management of technologies.

Others put forward that lack of adequate inputs and active information may be obstacles to adoption (Feder and Slade, 1984). These studies pertained to technologies in the developed countries but could apply to developing countries as well. The Kenyan dairy sub-sector is the single largest agricultural sub-sector. It contributes 14% of the agricultural GDP and 3.5% of total GDP (Muriuki *et al.,* 2003). It is of particular significance because it is dominated at producer level by smallholder dairy farmers (GOK, 2001). For some time there has been an estimated 650,000 dairy farm households in Kenya (Muriuki *et al.,* 2003). However based on random surveys of thousands of rural households by the Smallholder Dairy Project (SDP) in the mid 1990s and 2000s, it was estimated that the true number was much higher, over 1.5 million (GOK, 2005). Except during extreme drought, Kenya is generally self-sufficient in milk production and other dairy products. Annual milk production was estimated in 2003 at about 2.4 billion litres, although the Country had a domestic supply potential of 4 billion litres (Muriuki *et al.,* 2003). About 64% of milk produced was marketed while 36% was for domestic consumption at home or fed to calves. Small quantities of dairy products were also exported to neighbouring countries. Kenya imports very small quantities of dairy products, usually less than 1% of domestic production (Muriuki *et al.,* 2003). Between the year 1985 and 1995, annual powdered milk imports averaged 1,444 tones (Muriuki *et al.,* 2003).

Kenya can drastically increase milk supply and become a net exporter of dairy produce to meet rising trend of demand for dairy products which is being intensified by rising levels of population, urbanization, income and income elasticity of demand for dairy products (Thorpe, 1998). There are several interrelated ways of increasing milk production from a dairy cow. Improved feeding and better management of dairy animals can have quick short-term impact on milk production. However productivity of feeds, labour and resources in dairy production

will definitely depend on the quality of genetic base of the animals. Thus a long term strategy to enhance dairy production should be based on adoption of dairy technologies. Animal breeding programs have aimed at improving dairy productivity, shortening calving intervals and enhancing herd fertility by minimizing breeding diseases while eliminating the cost of keeping a bull (Rege *et al.,* 2001). The rapid and widespread adoption of exotic (*Bos Taurus*) dairy cattle has been a striking and positive feature in the history of livestock development in Kenya, beginning with the introduction by colonial settler-farmers in the early 1900s (ILRI, 2007). While annual milk production for local Zebu breeds (*Bos indicus*) ranges between 100 and 200 litres per cow per year, crossbreed or grade cows in Kenya produce 1400-1700 litres per year on smallholder farms, and more on larger commercial farms (Stall *et al.,* 2008). These figures lag behind the genetic potential of cattle, but still yield good profits to smallholder farmers. As has been demonstrated in numerous developing country settings, exotic breeds of cattle when crossed with local breeds can significantly improve milk yields in a sustainable manner.

It is estimated that dairy cattle contribute about 60% of national milk production while other indigenous breeds contribute the rest, 40% (Tegemeo, 2002). Dairy production is concentrated in the highlands and high and medium-potential areas of the Country, occupying about 2.8 million hectares of land (GOK, 2005).

Ranking milk production in 2005 by administrative provinces showed that; Rift Valley produced 47%; Central and Nairobi 31%, Eastern 11%, Nyanza 6%, Western 4% and Coast 1% of total production respectively (GOK, 2005). The figures showed that Rift Valley, Nairobi and Central provinces accounted for over 80% of the total dairy cattle population in the Country. In 2005 it was estimated that the population of dairy cattle was over 6.7 million (GOK, 2005), with 2.7 million being high grade cattle and 4 million being crosses. Studies also showed that there were approximately over 1.5 million rural smallholder farms. Based on these projections, total milk production in rural highlands is estimated at about 4 billion litres per annum and the population in rural areas is about 14.5 million people. Zebu cattle, estimated to constitute about 70% of the total cattle population are widely distributed across all provinces and agro-ecological zones (Tegemeo, 2002).

Within the livestock sector, dairy products contribute 30% of the GDP arising from livestock and 22% of livestock gross marketed products. The industry is also a major employer, employing about 841,000 people at farm level and providing further employment opportunities in the formal and informal milk value chains. The industry also contributes to nutritional well being of many households who consume various dairy products (GOK, 2010).

In spite of the crucial role of dairy in the Kenyan economy and the huge potential for further growth, productivity in the industry is constrained by unreliable breeding services, inadequate feed/fodder supply at farm level, poor quality of feeds, unreliable livestock health service, poor physical infrastructure and inefficient market system among others. In light of these limitations, several technologies and/or interventions have been developed and disseminated across the industry. Some of these technologies have been adopted by farmers with significant impacts on dairy productivity while others have failed to take off.

1.0 Technologies for Dairy Cattle Breeding: Animal breeding programs in Kenya have largely aimed at improving dairy productivity, shortening calving intervals and enhancing herd fertility among other goals (Rege, 2001). There is no explicit breeding policy in Kenya but various generic policy statements guide breeding programs in the Country (Staal et al., 2008). Generally, the policy statements aimed at increasing dairy productivity through breeding and selection implemented via wider use of AI and bull camps. A further goal is the production of high-yielding and disease resistant cattle types. The objective is therefore not to eliminate the indigenous gene but to integrate exotic gene to improve productivity while retaining the disease resistance and local adaptability traits of the indigenous gene.

Main institutions in dairy cattle breeding include Kenya Stud Book – keeping animal breeding records; Dairy Recording Service – keep milk performance data; Central Artificial Insemination Station (CAIS) – produce semen; and Kenya National Artificial Insemination Services (KNAIS) – distribute semen (Conelly, 1998). In

order to achieve the goals of the breeding policies, there are various dairy breeding technologies and interventions that have been introduced in the Country over the years. These include the following: sexed semen, Multiple ovulation and embryo transfer and Artificial insemination (A.I): This study focused on AI. This is one of the animal breeding technologies that have widely been promoted by government. Until the mid-1980s, there was a well organized dairy cattle breeding system subsidized by the government that contributed to growth of the smallholder dairy farming system (FAO, 2011). Consequently AI was used effectively to accelerate uptake of dairy farming by upgrading the local zebus. However, liberalization of the economy that led to reduced government involvement in breeding activities has seen a gradual replacement of government AI provision by private players, albeit at a slower rate (See Figure 1.1). Nevertheless, private AI services remain quite underdeveloped and this together with the perceived high cost of the service, has led to frequent use of bulls of unknown breeding value across the Country.
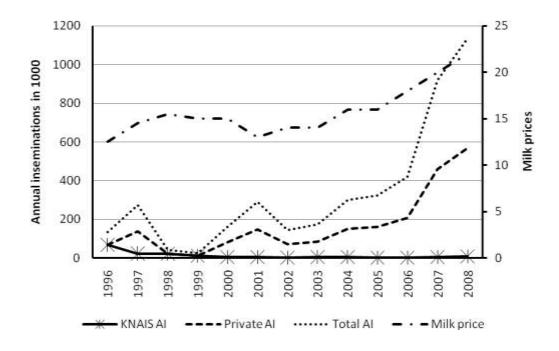

Figure 1.1: Annual Inseminations (KNAIS and Private) against Milk Prices
Source: FAO, (2011)

2.0 Factors Determining Adoption of Technologies: A variety of studies are aimed at establishing factors underlying adoption of various technologies. As such, there is an extensive body of literature on the economic theory of technology adoption. Several factors have been found to affect adoption. These include market forces, government policies, technological change, demographic factors, environmental challenges, institutional factors and methods of delivery of information.

Social factors that include: age of potential adopter, social status of farmers, education level and gender-related aspects, household size, and farming experience. Management factors that include: membership to organizations, the capacity to borrow, and concerns about environmental degradation and human health of farmers; Institutional/technology delivery mechanisms: information access, extension services, and prior participation in, and training in agricultural management.

Some studies classify the above factors into broad categories: farmer characteristics, farm structure, institutional characteristics and managerial structure (McNamara, *et al.,* 1991) while others classify them under social, economic and physical categories (Kebede and Gunjal, 1990). Others group the factors into human capital,

production, policy and natural resource characteristics (Wu and Babcock, 1998) or simply whether they are continuous or discrete (Shakya and Flinn, 1985). By stating that agricultural practices are not adopted in a social and economic vacuum, Nowak (1987) brought in yet another category of classification. He categorizes factors influencing adoption as informational, economic and ecological.

There is no clear distinguishing feature between elements within each category. Actually, some factors can be correctly placed in either category. For instance, experience as a factor in adoption is categorized under 'farmer characteristics' (McNamara *et al.* 1991; Tjornhom, 1995) or under 'social factors' (Kebede *et al.* 1990; Abadi *et al.* 1999) or under 'human capital characteristics' (Caswell *et al.* 2001).

Perhaps it is not necessary to try and make clear-cut distinctions between different categories of adoption factors. Besides, categorization usually is done to suit the current technology being investigated, the location, and the researcher's preference, or even to suit client needs. However, as some might argue, categorization may be necessary in regard to policy implementation. Extensive work on agricultural adoption in developing countries was pioneered by Feder *et al.* (1985). Since then the amount of literature on this subject has expanded tremendously. Because of this extensive literature, the following section provides a review of selected factors as they relate to agricultural technology adoption.

2.1 Farm Characteristics
Farm Size

Much empirical adoption literature focuses on farm size as the first and probably the most important determinant of adoption. Farm size is frequently analyzed in many adoption studies (Shakya and Flinn, 1985; Harper *et al.* 1990; Green and Ng'ong'ola, 1993; Adesiina and Baidu-Forson, 1995; Nkonya, Schroeder and Norman 1997; Fernandez-Cornejo, 1998; Baidu-Forson, 1999; Boahene, Snijders and Folmer, 1999; Doss and Morris, 2001; and Daku, 2002). This is perhaps because farm size can affect and in turn be affected by the other factors influencing adoption. In fact, some technologies are termed 'scale-dependant' because of the great importance of farm size in their adoption.

The effect of farm size has been variously found to be positive (McNamara *et al.* 1991; Abara and Singh, 1993; Feder *et al.* 1985; Fernandez - Cornejo, 1996, Kasenge, 1998), negative (Yaron, Dinar and Voet, 1992; Harper *et al.* 1990) or even neutral to adoption (Mugisa-Mutetikka *et al.,* 2000). Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Singh, 1993) especially if the technology requires a substantial amount of initial set-up cost, so-called "lumpy technology." In relation to lumpy technology, Feder, *et al.* (1985) further noted that only larger farms will adopt these innovations. With some technologies, the speed of adoption is different for small- and large- scale farmers. In Kenya, for example, a study (Gabre-Madhin and Haggblade, 2001) found that large commercial farmers adopted new high-yielding maize varieties more rapidly than smallholders.

Furthermore, access to funds (say, through a bank loan) is expected to increase the probability of adoption. Yet to be eligible for a loan, the size of operation of the borrower is crucial. Farmers operating larger farms tend to have greater financial resources and chances of receiving credit are higher than those of smaller farms.

A counter argument on the effect of farm size can be found in Yaron and others (1992) who demonstrated that a small land area may provide an incentive to adopt a technology especially in the case of an input-intensive innovation such as a labor-intensive or land-saving technology. In that study, the availability of land for agricultural production was low, consequently most agricultural farms were small. Hence, adoption of land-saving technologies seemed to be the only alternative to increased agricultural production.

Further, in the study by Fernandez-Cornejo (1998), farm size did not positively influence adoption. Most studies consider total farm size and not crop acreage on which the new technology is practiced. While total farm size has an effect on overall adoption, considering the crop acreage with the new technology may be a superior measure to predict the rate and extent of adoption of technology (Lowenberg-DeBoer, 2000). Therefore in regard to farm size, technology adoption may best be explained by measuring the proportion of total land area suitable to the new technology.

2.2 Economic Factors

Economic factors are important determinants of adoption. The effects of cost of technology, level of expected gains and off-farm hours on adoption are discussed below.

(i) Cost of Technology

The decision to adopt is often an investment decision. As Caswell *et al.,* (2001) noted, this decision presents a shift in farmers' investment options. Therefore adoption can be expected to be dependent on cost of a technology and on whether farmers possess the required resources. Technologies that are capital-intensive are only affordable by wealthier farmers (El Oster and Morehart, 1999) and hence the adoption of such technologies is limited to larger farmers who have the wealth (Khanna, 2001). In addition, changes that cost little are adopted more quickly than those requiring large expenditures; hence both extent and rate of adoption may be dependent on the cost of a technology. Economic theory suggests that a reduction in price of a good or service can result in more of it being demanded.

(ii) Level of Expected Gains

Programs that produce significant gains can motivate people to participate more fully in them. In fact, people do not participate unless they believe it is in their best interest to do so. Farmers must see an advantage or expect to obtain greater utility in adopting a technology. In addition, farmers must perceive that there is a problem that warrants an alternative action to be taken. Without a significant difference in outcomes between two options, and in the returns from alternative and conventional practices, it is less likely that farmers, especially small-scale farmers will adopt the new practice (Abara and Singh, 1993).

(iii) Off-Farm Hours

The availability of time is an important factor affecting technology adoption. It can influence adoption in either a negative or positive manner. Practices that heavily draw on farmer's leisure time may inhibit adoption (Mugisa-Mutetikka *et al.,,* 2000). However, practices that leave time for other sources of income accumulation may promote adoption. In such cases, as well as in general, income from off-farm labor may provide financial resources required to adopt the new technology.

2.3 Social Factors

(i) Age of Adopter

Age is another factor thought to affect adoption. Age is said to be a primary latent characteristic in adoption decisions. However there is contention on the direction of the effect of age on adoption. Age was found to positively influence adoption of sorghum in Burkina Faso (Adesina and Baidu-Forson, 1995). The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In addition, since adoption pay-offs occur over a long period of time, while costs occur in the earlier phases, age (time) of the farmer can have a profound effect on technology adoption.

However age has also been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions. In studies on adoption of land conservation practices in Niger (Baidu-Forson, 1999), rice in Guinea (Adesiina and Baidu-Forson, 1995), fertilizer in Malawi (Green and Ng'ong'ola, 1993), IPM sweep nets in Texas (Harper *et al.,,* 1990), Hybrid Cocoa in Ghana (Boahene, Snijders and Folmer, 1999), age was either not significant or was negatively related to adoption. Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method. In addition, farmers' perception that technology development and the subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of farmers' advanced age, and the possibility of not living long enough to enjoy it (Caswell *et al.,* 2001; Khanna, 2001). Furthermore, elderly farmers often have different goals other than income maximization, in which case, they will not be expected to adopt an income–enhancing technology. As a matter of fact, it is expected that the old that do adopt a technology do so at a slow pace because of their tendency to adapt less swiftly to a new phenomenon (Tjornhom, 1995).

(ii) Education

The common variables used for education studies are the education of the head of the household and average education of the farm workers. Researches have been done on the contributions of education to farm production efficiency (Dorfman, 1996). Generally education has been found to promote adoption of new technology and reduce lag time in most studies.

Studies that have sought to establish the effect of education on adoption in most cases relate it to years of formal schooling (Feder and Slade, 1984). Generally education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Waller *et al.* 1998; Caswell *et al.* 2001). What is more, adoption literature (Rogers, 1983) indicates that technology complexity has a negative effect on adoption.

However, education is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology's adoption. The ability to read and understand sophisticated information that may be contained in a technological package is an important aspect of adoption.

(iii) Gender

Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption. Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana, and Overfield and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption. The later study notes "effort in improving women's working skills does not appear warranted as their technical efficiency is estimated to be equivalent to that of males. Since adoption of a practice is guided by the utility expected from it, the effort put into adopting it is reflective of this anticipated utility. It might then be expected that the relative roles women and men play in both 'effort' and 'adoption' are similar, hence suggesting that males and females adopt practices equally.

2.4 Institutional Factors
(i) Information Acquisition

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 individual's assessment from purely subjective to objective over time (Caswell *et al.,,* 2001). Exposure to information about new technologies as such significantly affects farmers' choices about it. Feder and Slade (1984) indicated how, provided a technology is profitable, increased information induces its adoption. However in the case where

experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it.

Information is acquired through informal sources like the mass media, extension personnel visits, meetings, and farm organizations and through formal education. It is important that this information be reliable, consistent and accurate. Thus, the right mix of information properties for a particular technology is needed for effectiveness in its impact on adoption.

(ii) Extension Contacts

Good extension programmes and contact with products are a key aspect in technology dissemination and adoption. Most studies analyzing this variable in the context of agriculture technology show its strong positive influence on adoption. In fact Yaron, *et al.,* (1992) showed that its influence can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies.

3.0 Scope and Limitation of the Study: Kenya has diversified ecological zones that influence agricultural production. These ecological zones may influence the opportunities and resources that are available for agricultural production. It was therefore advisable to draw a sample from the whole nation, but time allocated for the study and availability of resources limited such widespread geographical distribution. Therefore one zone was chosen and a limited sample size of 360 dairy farmers was used. The study was confined to the North Rift region, yet it is easy to use the results of this research to gain insight into the whole country.

Inadequate financial outlay, time and logistical constraints prevented collection of data in all the divisions of the three counties (Nandi, Uasin Gishu and Trans-Nzoia).

The survey relied on voluntary information that is subject to many sources of error. The inaccuracy may have resulted of lack of farm records and illiteracy. Estimated farm size was for instance difficult and hence ability of researcher was relied on to verify accurately the information provided by respondents. Also, estimating monthly and annual income was difficult. Most farmers were unwilling to openly discuss issues related to income with outsiders.

To control errors, indirect questions were asked to verify and clarify doubtful responses. In some cases, probing questions were asked. Training and close supervision of the enumerators were additional strategies used to improve quality of data.

4.0 Materials and Methods: The primary data was collected from household heads interviewed in this study. The information included age of the farmer (in years), education level of the famer (either primary, secondary and tertiary level), cost of technology (in Kshs), farm size under fodder, farmer's income (in Kshs), gender (male or female) and availability of extension services.

Secondary data was collected from sources that included books, economic surveys, World-Wide Web, statistical reports, scholarly journals, thesis and dissertations, bulletins, monthly and annual reports and Government publications such as respective Region's Development Plans.

The research design that was chosen for the study was cross-sectional research design (or a survey research design). This design allowed the researcher to examine the effects of the naturally occurring influence of the independent variables (socio-economic factors) on the dependent variable (adoption of AI). In addition the design allowed the researcher to apply aspects of survey research to track adoption of the AI technology in the North Rift region.

Dairy farming households were used as units of analysis because it is in the households that major decisions relating to production are made. Each household was visited once and responses recorded on the questionnaire. The study targeted all dairy farmers in North Rift region.

According to Saunders *et al.* (2007), sampling techniques can be divided into two types: Probability or representative sampling and; Non-probability or judgmental sampling. In probability or representative sampling, the chance or probability of each case being selected from the population is known and is usually equal for all cases. It is most commonly associated with survey–based research where one needs to make inferences from a sample about a population to answer research questions or to meet set objectives. For the case of non-probability or judgmental sampling, the probability of each case being selected from the population is not known and it is impossible to answer research questions or to address objectives that require making statistical inferences about characteristics of the population.

The minimum recommended sample size for survey studies is 100 (Kathuri and Pals,1993), but the study took a total of 360 dairy farmers from the three counties proportionately determined to ensure that the main characteristics of the farmers were captured. The sample size was large enough to allow reasonable and accurate interpretation of the results.

4.10 Data Collection Procedures
Permission to conduct research in North Rift region was sought from the Nandi, Trans Nzoia, and Uasin Gishu Counties' Region Headquarters Office. Letter of authority to conduct research was also requested from the Office of the County Commissioner of each of the three counties. The target population was all dairy farmers in North Rift region that entails Uasin Gishu, Nandi and Trans-Nzoia counties. The initial research work began by contacting the County Agricultural Officer and the County Agricultural Extension Officer to inform them of the intended visit and to have the officers brief the researcher on the farming activities in the three counties. Agricultural Officers of the two divisions chosen were also visited, who in conjunction with the village elders, helped identify the targeted population for the researcher. Each of the selected farmers was visited at home once and an interview schedule conducted during the visit. Each question was read to the respondent and the latter's responses were recorded.

The data was then analyzed using STATA Econometric software version10.0. Descriptive statistics such as means, maximum, minimum and deviation values were used to summarize quantitative variables.

4.1.1 Descriptive Statistics
Descriptive statistics provided descriptive analysis of selected households. The technique was of great value in analyzing all the quantitative data. In this case, cross tabulation, frequency tables and general statistics such as means, standard deviations of certain variables were worked out. Descriptive measures were derived for farmer characteristics such as age, gender and income levels that enabled the researcher to understand their socio-economic standing as a possible indicator to their willingness and ability to take up new technologies in dairy management.

4.1.2 Regression Analysis
All regression analyses were done using STATA 10.0 using inbuilt commands for Logit estimation, likelihood ratio test, goodness of fit, pseudo R-Squared, prediction test, marginal effects test, marginal probability model, predict at means (at reference point) and fixed effects.

4.1.3 Inferential Statistics
Inferential statistics enabled the researcher to infer sample results to the general population. Descriptive analysis identified the characteristics of variables under study and made certain population estimates such as central tendencies and measures of dispersion; while regression analysis was used to find out the existence of

significant relationships among variables between farmer characteristics and their willingness to adopt improved breeding technologies. Characterization of farmers' level of awareness and adoption of the various technologies under study was mainly done using percentages that enabled estimation of the level of adoption of the various technologies. Multicollinearity check was performed by analyzing correlations between independent variables and any values equal or less than 5% level of confidence was insignificant.

The adoption levels for the two groups of farmers (small scale and large scale farmers) were determined. The t-test statistics were then used to determine the difference in level of adoption of improved dairy technologies between the small scale and large scale farmers. All tests of significance were computed at $\alpha = 0.05$. Respondents were asked to enumerate the challenges they face in the use of the breeding technologies. The frequencies, percentages and rankings of the challenges were done for the responses that they gave.

5.0 Socio-Economic Profile of the Household Heads (Farmers)

The descriptive statistics of the surveyed households are presented in table 4.1 below.

Table 5.1: Socio-economic Profile of the Household Heads (Farmer)

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	360	46.325	10.3648	24	75
Gender	360	0.8278	0.3781	0	1
Education level of the farmer	360	2.1583	0.8542	1	4
Cost of AI service KSh(000)	360	2.0778	1.2840	0	4
Cost of fodder in KSh (000)	360	2.7444	1.3440	0	5
Cost vaccines in KSh (000)	360	3.6150	5.9380	0	47
Farm income in KSh (000)	360	293.6356	392.8900	8	3870
Farm size in acres	360	8.1207	18.0354	0.1	300
Off farm income in KSh (000)	360	42.7778	104.7295	0	1200
Land under fodder in acres	360	3.5678	7.1307	0.5	100
Land tenure system	360	2.8111	0.5360	1	3
Access to extension service	360	0.3639	0.4875	0	2
Frequency of extension visits	360	4.1750	0.8704	2	5
Awareness Artificial Insemination	360	0.8306	0.3757	0	1
Awareness of fodder	360	0.7222	0.4485	0	1
Awareness of vaccines	360	0.9500	0.2182	0	1
Use of Artificial Insemination	360	0.7111	0.4539	0	1
Use of fodder	360	0.7611	0.4270	0	1
Use of vaccines	360	0.8694	0.3374	0	1

Source: Data Analysis Results, 2014

There were a total of 360 respondents during the study. The background information of the respondents included; age, gender, education level, cost of selected technology, farm income, off-farm income, farm size, land under fodder, land tenure, access to extension services, frequency of extension visits, awareness level of the selected technologies, use of selected technology and main challenges in the use of the selected technologies.

5.1.1 Age Distribution of Household Heads

Figure 4.1 below shows the age distribution of the sampled household heads. The average age of the 360 farmers was 46 years. This shows that most of them were within the most active age in terms of farm activities.

5.1.2 Gender Distribution of Household Heads

Figure 4.2 below shows the gender distribution of sampled household heads. The results showed that 83% were men and 17% were female. This scenario gives the indication that men dominated household farming decisions in North Rift region. Gender of the household may have varied effects on use of a technology. Male farmers are

likely to have more access to inputs, capital and information through farmers' networks and contacts with extension agents than female farmers (Dey, 1981).

5.1.3   Level of Formal Education Attained by Household Heads in North Rift Region

The study sought information on education levels of the head of the household which is presented in figure 4.3. The mean education level of the farmers was secondary level. These results are consistent with Feder *et al.* (1985) who reported that majority of the respondents were under medium level of education. This is an indication that on average the farmers were enlightened and hence they may be front runners in the adoption of dairy technologies. Since their education may enhance their access to information and willingness to try out new innovations (Schultz, 1981). Education represents quality of human capital since it is thought to be largely responsible for improving access to new technology and the general economic welfare of the people (Schultz, 1981).

Figure 5.3: Level of Formal Education Attained by Household Heads in North Rift Region
Source: Survey Data, 2014.

5.1.4 Size of Land Owned

Figure 4.4 gives a summary of information on land size owned by the farmers in North Rift region. Most of the respondents were small scale farmers. The average landholding was found to be 8.1 acres. Misra (1990) and Kannan (2002) in their respective studies in India reported that majority of the respondents had medium size of land holdings.

5.1.5 Land Tenure

The results on land tenure showed that on average the farmers in North Rift region owned land under freehold system. This means that they had the potential of utilizing their land for long term projects and title deeds to access loan facilities from financial institutions for agricultural development.

5.1.6 Extension Services

Results on extension services showed that very few (30%) of the farmers received extension services in North Rift region. This means that extension activities were very rare in the region. The results on frequency of extension visits showed that on average, the farmers in North Rift region were visited four times in a year by the extension personnel. This frequency is low given that the farmers require continuous information throughout the year for them to effectively implement what they are advised to do. Education is a source of information about better farming practices. Frequent extension contacts are expected to positively impact on adoption of dairy technologies by farmers (Bonabana-Wabbi, 2002).

5.1.7 Farmers' Farm and Off-farm Income

Information on income sources was sought since income is an important determinant in technology choice (Mose, 2013). The farmers' farm income throughout the year on average was found to be KSh. 293,635 with minimum of KSh. 8000 and maximum of KSh. 3,870,000. The average off-farm income was KSh. 42,778 with minimum of zero and maximum of KSh.1,200,000. This showed that the farmers mainly depended on income from the farm and rarely on off-farm sources.

5.1.8 Farmers' Livestock Features

The results on livestock features showed that farmers in North Rift region on average used 3.6 acres of land for fodder and a majority (76%) used fodder to feed their livestock; whereas 71% used AI services and 87% vaccinated their livestock against diseases.

5.1.9 Cost of Technology

The cost of technologies considered for this study included AI, fodder and vaccines. The average amounts incurred by respondents were KSh. 2,078, KSh. 2,744 and KSh. 3,615 for artificial insemination, fodder and vaccination respectively.

5.1.10 Farmers' Technology Awareness Levels

Information was sought on farmers' awareness of technology. Results showed that most farmers were aware of existence of dairy technologies such as AI, fodder and vaccine technologies; however the awareness levels varied from one technology to another.

5.2 Determination of Level of Awareness of Selected Dairy Technologies

Farmers were asked to state whether they were aware of the existence of selected dairy technologies. The technologies considered were breeding, feeding and healthcare. The results of the awareness level are summarized on tables 4.2, 4.3 and 4.4.

5.2.1 Level of Awareness of Selected Dairy Breeding Technologies

The first objective of this research was to establish the level of awareness of the existence of the selected dairy technologies among farmers in North Rift region. The results are reported in table 5.2 below. These results showed that farmers were aware of the existence of selected dairy technologies. The awareness levels varied from one breeding technology to another with awareness levels ranging from 83 percent(on AI) to 19 percent for embryo transfer.

Table 5.2: Level of Awareness of Breeding Technologies

Awareness of Selected Breeding Technology	Frequency	Percent	Rank
AI services	299	83	1
Gender selected/sexed semen	128	36	2
Multiple ovulation/embryo transfer	67	19	3

Source: Data Analysis Results, 2014

The results therefore showed that farmers were aware of existence of selected breeding technologies at varied levels but were constrained from using them by some reasons.

The first objective of this research was to determine the level of awareness of selected breeding technologies by farmers in North Rift region. The results showed that dairy farmers in North Rift region were aware of the existence of the selected breeding technologies although at varying levels as shown on tables 5.2,

5.3 Regression Results on Selected Dairy Technologies

Regressions were done on use of selected dairy technologies and the results are presented in the subsequent sub-sections.

4.3.1.1 Logit Regression Results on Use of Artificial Insemination

The estimated binary logit regression results on use of artificial insemination are reported in Table 4.5. With five iterations, Likelihood ratio was found to be 108.49. The Pseudo R^2 value obtained by estimation of equation 3.06 was 0.2507. This showed that the model satisfied the goodness of fit test. The Pseudo R^2 value (0.2507) for the overall model was satisfactory for survey studies; (Cameron and Trivedi, 2005). The Log likelihood was found to be small and negative (-162.16806) as expected in categorical data (Yamano, 2009). These results also showed that the model fitted the data very well (Prob $> \chi^2 = 0.0000$).

The regression results showed that, age of the farmer, was significant determinant of adoption of artificial insemination (P-value $0.033 < 0.05$). The results further showed that age of the farmer had a negative and significant effect on adoption of artificial insemination. This is consistent with Quddus (2010) and Feder *et al.* (2001) who found out that age is negatively related to technology adoption.

The first hypothesis of this research stated that social factors such as age, education level and gender of farmers do not significantly affect adoption of selected dairy technologies among farmers in North Rift region. The results reported in Table 4.5 showed that age of the farmer significantly affected adoption of artificial insemination and therefore the first hypothesis was rejected in the case of adoption of artificial insemination technology by farmers.

Table 4.5: Logit Regression Results for Adoption of Artificial Insemination as a Technology

Number of observations $= 360$

$LR\ \chi^2\ (11) = 108.49$

$\Pr ob > \chi^2 = 0.0000$

Log Likelihood $= -162.16806$ $Pseodo\ R^2 = 0.2507$

Use of Artificial Insemination	Coef	Std. Err.	Z.	P> |Z|	χ^2
Age of the farmer	-0.0298	0.0140	-2.13*	0.033	4.52
Education level	0.3340	0.1762	1.90	0.058	3.59
Gender	-0.0847	0.3642	-0.23	0.816	0.05
Cost of Artificial Insemination	1.0520	0.1716	6.13*	0.000	37.58
Farm income	-0.0007	0.0004	-1.77	0.077	3.13
Off-farm income	0.0026	0.0024	1.06	0.291	1.11
Farm size in acres	0.0138	0.0132	1.04	0.296	1.09
Land under fodder	-0.0513	0.0310	-1.65	0.099	2.73
Land tenure	-0.4000	0.2901	-1.38	0.168	1.90
Access to extension services	0.6419	0.4152	1.55	0.122	2.39
Frequency of extension visits	0.1559	0.2411	0.65	0.518	0.42
Constant	0.3860	1.6415	0.24	0.814	

Legend "*" indicates that the statistic is significant at 5% level.

Source: Data Analysis Results, 2014

The second hypothesis of this research stated that economic factors such as cost of selected technology, farmer's farm income, and farmer's off-farm income do not significantly affect adoption of selected dairy technologies among farmers in North Rift region. The results showed that cost of artificial insemination significantly affected adoption of artificial insemination among farmers in North Rift region (P-value = 0.0000 < 0.05). Therefore this hypothesis was also rejected in the case of adoption of artificial insemination technology by farmers.

The joint significance test for Logit model is like an F-test for the maximum likelihood estimation. If LR is a large number (if there is a significant difference in L_r and L_{ur}), in Equation 3.12 then the additional variables in the unrestricted model are jointly significant (Cameron and Trivedi, 2005, 2009; Long and Freese, 2003). The results showed that the Log

Likelihood was a large number (108.49). Therefore it was concluded that socio-economic factors jointly affected the farmers' decision to adopt AI services in North Rift region. These confirm the rejection of the first and second hypotheses.

4.3.1.2 Logistic Regression Results: Odds Ratios on Use of Artificial Insemination

The odds ratios on use of artificial insemination are reported in table 4.6 below.

Table 4.6: Logistic Regression Results for Adoption of Artificial Insemination

Number of observations = 360

$$LR\ \chi^2\ (11) = 108.49$$

$$\Pr ob > \chi^2 = 0.0000$$

Log Likelihood = -162.16806

$$Pseodo\ R^2 = 0.2507$$

Use of Artificial Insemination	Odds Ratio	Std. Err.	Z.	P> |Z|	χ^2
Age of the farmer	0.9706	0.0136	-2.13*	0.033	4.52
Education level	1.3966	0.2461	1.90	0.058	3.59
Gender	0.9188	0.3347	-0.23	0.816	0.05
Cost of Artificial Insemination	2.8634	0.4914	6.13*	0.000	37.58
Farm income	0.9992	0.0004	-1.77	0.077	3.13
Off-farm income	1.0025	0.0024	1.06	0.291	1.11
Farm size in acres	1.0138	0.0134	1.04	0.296	1.09
Land under fodder	0.9500	0.0295	-1.65	0.099	2.73
Land tenure	0.6703	0.1945	-1.38	0.168	1.90
Access to extension services	1.9001	0.7889	1.55	0.122	2.39
Frequency of extension visits	1.1687	0.2818	0.65	0.518	0.42

Legend "*" indicates that the statistic is significant at 5%.

Source: Data Analysis Results, 2014

With 360 observations the likelihood ratio was found to be 108.49. The modeled variables were found to be satisfactory (Prob > χ^2 = 0.0000 < 0.05). The results of logistic regression showed that for a one unit increase in age of the farmer, decreased the odds ratio of using artificial insemination by 0.9706. The other covariates that decreased the odds ratio of using artificial insemination by farmers were found to be gender, farm income, land under fodder and land tenure (Odds ratios < 1). Education level, cost of artificial insemination, off-farm income, farm size, access to extension services and frequency of extension visits were expected to increase the odds for adoption of artificial insemination by farmers (Odds ratios > 1)

4.3.1.3 Marginal Effects on Use of Artificial Insemination

The results of analysis of marginal effects are reported in table 4.7.

Table 4.7: Marginal Effects for Adoption of Artificial Insemination

$M\ \arg inal\ Effects\ after\ Logit\ Y = \Pr(Use\ Artificial\ Inse\min ation)(predict) = 0.80600237$

Use of Artificial Insemination	∂_y / ∂_x	Std. Err.	Z.	P> |Z|	X
Age of the farmer	-0.0047	0.0022	-2.10	0.036	46.325
Education level	0.0522	0.0277	1.88	0.060	2.1583
Gender*	-0.0130	0.0551	-0.24	0.813	0.8278
Cost AI services	0.1645	0.0212	7.74	0.000	2.0778
Farm income	-0.0001	0.0001	-1.76	0.079	293.64
Off-farm income	0.0004	0.0004	1.07	0.286	42.778
Farm size in acres	0.0022	0.0021	1.03	0.302	8.1207
Land under fodder	-0.0080	0.0049	-1.63	0.103	3.5679
Land tenure	-0.0625	0.0455	-1.37	0.169	2.8111
Access to extension services	0.1004	0.0653	1.54	0.124	0.3639
Frequency of extension visits	0.0244	0.0378	0.64	0.519	4.1750

Legend: (*) shows that for gender ∂_y / ∂_x is for discrete change of dummy variable from 0 to 1.

Source: Data Analysis Results, 2014

The results of marginal effects showed that the predicted probability of using artificial insemination is 0.80600237 (80.6%) for farmers at the average age of 46.325 years, with secondary school education level and average income of KSh. 293,635.60. Marginal effects and discrete changes are listed under ∂_y / ∂_x.

The marginal effects showed that for a unit increase in age of the farmer, the predicted probability of using artificial insemination decreased by 0.47 percent, holding other independent variables constant at the reference points (see the list of values under the label X). The other independent variables that decreased adoption of artificial insemination were found to be; gender, farm income, land under fodder and land tenure, holding other covariates at the reference points ($\partial_y / \partial_x < 0$).

The marginal effects results further showed that for a unit increase in education level of the farmer, the predicted probability of using artificial insemination increased by 5.22 percent, holding other independent variables constant at the reference points. The other independent variables that increased predicted probability to adopt artificial insemination technology by farmers were found to be; cost of artificial insemination, off-farm income, farm size, access to extension services and frequency of extension visits, holding other covariates at their reference points ($\partial_y / \partial_x > 0$).

```
. mfx, dydx at(mean age = 42 gender = 0)

Marginal effects after probit
      y  = Pr(will) (predict)
         =   .67496562

variable |    dy/dx    Std. Err.     z    P>|z|  [    95% C.I.    ]      X
---------+--------------------------------------------------------------------
 gender* | -.0290454     .03768   -0.77   0.441  -.102889   .044798        0
    age  |  .0067506     .00231    2.92   0.003   .00222    .011281       42
   educ  | -.0061451     .01068   -0.58   0.565  -.027073   .014782  12.2869
   rent  | -.0001118     .00003   -3.62   0.000  -.000172  -.000051  2267.27
    tax  |  .0290609     .00788    3.69   0.000   .013621   .044501  12.4914
 income  |  8.83e-06     .00000    4.77   0.000   5.2e-06   .000012  23080.6
 period  |  .0113437     .0057     1.99   0.047   .000171   .022516  8.80876
   rate  |  .0221246     .00587    3.77   0.000   .010625   .033624  8.62351
---------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

4.3.1.4 Factor Change in Odds Ratio on use of Artificial Insemination as a Technology (Male versus Female)

Long (1997), discusses interpretation of binary response models using factor changes in odds and predicted probabilities. The results of factor change in odds ratio are reported in Table 4.8. The results showed that for a unit increase in age of the farmer, the odds are expected to decrease by a factor of 0.9706 = exp (-0.0298). Alternatively, for a standard deviation change in age, the odds will change by a factor of 0.7339 = exp (-0.02984*10.3648). The last column under *SDofX* lists standard deviations of covariates. The other independent variables that decreased the odds are gender, farm income, land under fodder and land tenure (Odds < 1); whereas those that were expected to increase the odds were education level, cost of artificial insemination, off-farm income, farm size, access to extension services and frequency of extension visits (Odds > 1).

Table 4.8: Factor Change in Odds for Adoption of Artificial Insemination (1 versus 0)

$Logit\,(N = 360):Factor\,Change\,in\,Odds:Odds\,of\,1\,versus\,0\,(male\,versus\,female)$						
Use of artificial insemination	B	Z	P > |Z|	E ^ B	E^BStdX	SD of X
Age of the farmer	-0.0298	-2.127*	0.033	0.9706	0.7339	10.3648
Education level	0.3340	1.895	0.058	1.3966	1.3302	0.8542
Gender	-0.0846	-0.232	0.816	0.9188	0.9685	0.3781
Cost of Artificial Insemination	1.0520	6.130*	0.000	2.8635	3.8604	1.2840
Farm income	-0.0007	-1.769	0.077	0.9993	0.7504	392.89
Off-farm income	0.0026	1.056	0.291	1.0026	1.3083	104.73
Farm size in acres	0.0138	1.045	0.296	1.0139	1.2824	18.036
Land under fodder	-0.0513	-1.652	0.099	0.9500	0.6938	7.1307
Land tenure	-0.4000	-1.379	0.168	0.6703	0.8070	0.5360
Access to extension services	0.6419	1.546	0.122	1.9001	1.3675	0.4875
Frequency of extension visits	0.1559	0.646	0.518	1.1687	1.1453	0.8704

Legend: B = raw coefficient, Z = Z-Score for test of B = 0, P > |Z| = p-value for Z-test, E^B = exp(P) = factor change in odds for unit increase in X *E^BStdX = exp(B*SD of X)* = change in odds for SD increase in X and *SDofX* = Standard Deviation of X. "*" indicate that the change in Odds is statistically significant at 5% level.

Source: Data Analysis Results, 2014

4.3.1.5 Factor Change in Odds Ratio on Use of Artificial Insemination as a Technology (Female versus Male)

The factor change in odds was also reported and interpreted in a reverse order (0 versus 1). These results are reported in Table 4.9. The results showed that for a standard deviation change in age of the farmer, the odds of using artificial insemination were expected to increase by a factor of 1.3625=exp(-0.02984*10.3648). This result showed that female farmers are better adopters of artificial insemination compared with their male counterparts. The $E \wedge B$ values were 1.0303 and 0.9706 for female and male respectively (tables 4.8 and 4.9). The other covariates that were expected to increase the odds of using artificial insemination were found to be gender, farm income, land under fodder and land tenure if the household heads were female (Odds > 1). Education level, cost of artificial insemination, off-farm income, farm size, access to extension services and frequency of extension visits were expected to decrease the odds for adoption of artificial insemination by households that were headed by female (Odds < 0)

Table 4.9: Factor Change in Odds for Adoption of Artificial Insemination (0 versus 1)

Logit $(N = 360)$: *Factor Change in Odds*: *Odds of* 0 *versus* 1 (*female versus male*)						
Use of artificial insemination	*B*	*Z*	*P > |Z|*	*E ^ B*	*E^bStdx*	*SD of X*
Age of the farmer	-0.0298	-2.127*	0.033	1.0303	1.3625	10.3648
Education level	0.3340	1.895	0.058	0.7160	0.7518	0.8542
Gender	-0.0846	-0.232	0.816	1.0884	1.0325	0.3781
Cost of Artificial Insemination	1.0520	6.130*	0.000	0.3492	0.2590	1.2840
Farm income	-0.0007	-1.769	0.077	1.0007	1.3327	392.89
Off-farm income	0.0026	1.056	0.291	0.9974	0.7643	104.73
Farm size in acres	0.0138	1.045	0.296	0.9863	0.7798	18.036
Land under fodder	-0.0513	-1.652	0.099	1.0526	1.4414	7.1307
Land tenure	-0.4000	-1.379	0.168	1.4918	1.2391	0.5360
Access to extension services	0.6419	1.546	0.122	0.5263	0.7313	0.4875
Frequency of extension visits	0.1559	0.646	0.518	0.8557	0.8731	0.8704

Legend: b = raw coefficient, Z = Z-Score for test of B = 0, p > |Z| = p-value for z-test, E^B = exp(P) = factor change in odds for unit increase in x E^BStdx = exp(B*SD of X) = change in odds for SD increase in X and SDofX = Standard Deviation of X. "*" indicate that the change in Odds is statistically significant at 5% level.

Source: Data Analysis Results, 2014

4.3.1.6 Percentage Change in Odds for Adoption of Artificial Insemination as a Technology

The results of percentage change in odds for adoption of artificial Insemination for forward model (1 versus 0) are presented in table 4.10 below. The percentage change in odds for adoption of AI technology showed that a unit increase in age of a male farmer led to reduction in odds ratio by 2.90%. The other covariates that had negative outcomes were gender, farm income, land under fodder and land tenure. The results showed that education level, cost of artificial insemination, off-farm income, farm size in acres, access to extension services and frequency of extension visits. Cost of artificial insemination had the highest percentage change in odds (186.3). This implies that cost of AI is the highest predictor of technology adoption.

Table 4.10: Percentage Change in Odds for Adoption of Artificial Insemination (1 versus 0)

Logit $(N = 360)$: *Percentage Change in Odds* : *Odds of* 1 *versus* 0 (*male versus female*)

Use of artificial insemination	B	Z	P > |Z|	%	%StdX	SD of X
Age of the farmer	-0.0298	-2.127*	0.033	-2.90	-26.60	10.3648
Education level	0.3340	1.895	0.058	39.7	33.00	0.8542
Gender	-0.0846	-0.232	0.816	-8.100	-3.200	0.3781
Cost of Artificial Insemination	1.0520	6.130*	0.000	186.3	286.0	1.2840
Farm income	-0.0007	-1.769	0.077	-0.100	-25.00	392.89
Off-farm income	0.0026	1.056	0.291	0.300	30.80	104.73
Farm size in acres	0.0138	1.045	0.296	1.400	28.20	18.036
Land under fodder	-0.0513	-1.652	0.099	-5.000	-30.60	7.1307
Land tenure	-0.4000	-1.379	0.168	-33.00	-19.30	0.5360
Access to extension services	0.6419	1.546	0.122	90.00	36.70	0.4875
Frequency of extension visits	0.1559	0.646	0.518	16.90	14.50	0.8704

Legend: B = raw coefficient, Z = Z-Score for test of B = 0, P > |Z| = P-value for Z-test, E^B = exp(p) = factor change in odds for unit increase in x e^bStdx = exp(b*SD of X) = change in odds for SD increase in X and *SDofX* = Standard Deviation of X. "*"indicate that the change in Odds is statistically significant at 5% level.

Source: Data Analysis Results, 2014

4.3.1.7 Predicted Probabilities for Possible Outcomes for Use of Artificial Insemination

The results of predicted probabilities for possible outcomes for use of artificial insemination are presented on table 4.11 below. The results showed that cost of artificial insemination was the best predictor variable (16.18%) of use of artificial insemination by farmers (100*-+*1/2)*. The results further showed that age, gender, farm income land under fodder and land tenure reduced the probability of using artificial insemination technology by farmers.

Table 4.11: Predicted Probabilities for Adoption of Artificial Insemination

Use of fodder	Min->Max	0 -> 1	-+1/2	-+Sd/2	MargEfct
Age of the farmer	-0.2473	-0.0016	-0.0046	-0.0474	-0.0046
Education	0.1694	0.0758	0.0512	0.0437	0.0512
Gender of the farmer	-0.0127	-0.0127	-0.0130	-0.0049	-0.0130
Cost of Artificial Insemination	0.6448	0.2547	0.1618	0.2080	0.1613
Farm income	-0.6015	-0.0001	-0.0001	-0.0440	-0.0001
Off-farm income	0.1945	0.0004	0.0004	0.0412	0.0004
Farm size	0.2023	0.0023	0.0021	0.0381	0.0021
Land under fodder	-0.8075	-0.0071	-0.0079	-0.0561	-0.0079
Land tenure	-0.0994	-0.0311	-0.0613	-0.0329	-0.0613
Access to extension service	0.1283	0.0797	0.0985	0.0480	0.0984
Frequency of extension visits	0.0765	0.0323	0.0239	0.0208	0.0239

Source: Data Analysis Results, 2014

5.4 Conclusions

The first objective was to determine the level of awareness of selected breeding technology among the farmers in North Rift region. Based on the results it was concluded that farmers were aware of the existence of selected breeding (AI) technology but at varied levels. The results showed that awareness level for breeding technology (embryo transfer at 19%),AI at 83% and for sexed semen at 36% .

The second objective was to determine if social factors such as age , gender and education level of the farmer significantly affect adoption of selected breeding technology among the farmers in North Rift region. Based on the results it was concluded that age, gender and education level jointly and significantly affected adoption of selected breeding technologies.

The third objective was to determine if economic factors such as farm income, off-farm income, and land size significantly affect adoption of selected dairy technology among the farmers in North Rift region. Based on the results it was concluded that off-farm income, land size, jointly and significantly affected adoption of selected breeding technologies.

The fourth objective of this research was to determine if there was significant difference in adoption levels between small and large scale farmers in North Rift region. The results showed that there was significant difference in adoption levels between the two groups of farmers.

The fifth objective of this research was to establish the challenges facing farmers in adoption of breeding technologies in North Rift region. The results showed that constraints affecting the adoption of breeding technologies varied. The cited challenges on use of breeding technologies were; repeated service, infection of the dairy animal, high cost of AI services; accessibility of AI services and lack of expert personnel on AI services.

Based on the findings of this research it was recommended that;

(i) The Government should enhance farmers' education through adult literacy and extension education so as to improve up-take of dairy technologies.

(ii) The Government should introduce cost sharing programs for artificial insemination services .

(iii)There is need to encourage farmers through extension education so that they diversify their enterprises, to have other sources of income other than from the farm.

(iv)The Government should discourage land fragmentation and encourage land consolidation so as to improve dairy production.

(v) There is need for the Government to employ more extension personnel to increase their presence at the farm level and provide means of transport to increase the frequency of visits to the farmers.

(vi) The Government should empower women through funding and education for knowledge and skills since the results showed that women were better adopters of selected breeding technologies.

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