General Articles

Factors Influencing Adoption Of Dairy Goats In Meru County, Kenya: Prospects And Constraints

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Abstract

Improving milk production through crossbreeding of local goats with exotic breeds has increasingly become important in developing countries. Although, the dairy goat technology has been promoted in the central Kenyan highlands for more than a decade, very little documentation has been done on the uptake of the technology. A household survey was conducted among 260 randomly sampled smallholder farmers and a Probit model used to explain the influence of socio-economic and demographic characteristics, agro-ecological conditions, technological and use aspects, and external support services on the probability of adoption. Results showed that these factors are important in determining farmers' adoption decision.

Key words: Dairy goats, adoption, technology uptake, Kenya

Introduction

Livestock development projects have a potential to contribute to poverty reduction through increased farm incomes. They often act as catalysts that enable farm households to join the market economy and subsequently achieve a decent standard of living (ILRI, 2007). In the greater part of East Africa, keeping of dairy cattle by smallholder farm families is viewed by governments and development agencies as a means of increasing accessibility to high quality nutrients, and as a source of cash income to purchase other foods Dairy cattle projects involve high costs, and this leads to exclusion of resource-poor households from participating in dairy cattle husbandry (Bachmann, 2005,Staal et al., 1997.). Rapid population growth has resulted in further land subdivision, additionally exacerbated inadequacy of arable land that is much needed for the production of both food crops and fodder for dairy cattle.

The dairy goats are regarded as part of the solutions to the problems of maximization of land use due to their compatibility with smallholder farming systems in high potential areas (Ahuya, et al., 2005). Due to their small size, the dairy goats' feed requirement is low compared to that of dairy cows. They also occupy a small area and produce enough milk for the average family, and hence have been nicknamed the "poor man's cow" (Saif et al., 2004). According to Ahuya et al. (2005), goats have a short reproductive cycle and high incidence of multiple births. They thrive in virtually all climatic zones and under any production system (Smith and Sherman, 1994). Increasing productivity of local goats through crossbreeding with exotic breeds is increasingly being viewed as one of the ways of improving incomes and levels of animal protein among rural communities (Shavulimo, 1989; Peacock, 2008).

Economists and sociologists have made extensive contributions to the literature on adoption and diffusion of technological innovations in agriculture (Feder et al., 1985; Rogers, 1995; Adesina and Chianu, 2002). The earlier focus of most studies however was on adoption of improved crop varieties and it is not until recently that attention has shifted to the adoption of new livestock management practices (Doss, 2006).. For instance in Kenya most of the livestock studies,

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with the exception of Baltenweck and Staal (2000), Staal *et al.*, (2002) and Makhoha (2005), dwell on livestock production systems, diseases and management practices. In the Central Kenyan highlands, the initiative to promote dairy goats was taken up in the 1980s and 1990s by the German Technical Cooperation (GTZ), Food and Agricultural Research Management in Africa (FARM-Africa), in collaboration with local partners including the Kenya Agricultural Research Institute (KARI), Ministry of Agriculture (MoA) and Ministry of Livestock and Fisheries Development (MoLFD). The main aim of this initiative was to improve the income of the poor farmers in the region. This resulted in the introduction of pure exotic dairy goat breeds and crosses of German Alpine, Toggenburg, Anglo-Nubian and Saanen.However, as is often the case with many development programmes in the developing world, the uptake of these dairy goat breeds and their crosses has been experiencing reduced external support after withdrawal of donor funding (Peacock, 2008). Reasons cited for this trend include government agents and policy makers' lack of understanding of factors favoring dairy goat adoption and the absence of vital data on characterization and documentation of performance of breeds (FARM-Africa, 2006). While the latter problem is now being tackled though group-based or community based recording schemes (Ahuya et al., 2005), the former has not been addressed. The lack of understanding of what kind of farmers can potentially adopt dairy goats and/or which factors can enhance adoption has largely contributed to the patchy and ineffective attempts by governments to promote this sector and especially after withdrawal of foreign development partners (Peacock, 2008).

In an attempt to address this problem, this case study examines the determinants of dairy goat adoption in Meru Central and Meru South Districts in Kenya which is one of the areas where FARM-Africa was involved in the promotion of dairy goats in 1996-2004. It hypothesizes the adoption of the dairy goat technology is influenced by, among other factors, socioeconomic and demographic characteristics of farmers, technological and use aspects of dairy goats, support services, and environmental factors. It is expected that an understanding of the importance of these factors will guide targeting of farmers and regions, and prioritization for enhanced uptake of dairy goat technology even after withdrawal of foreign aid.

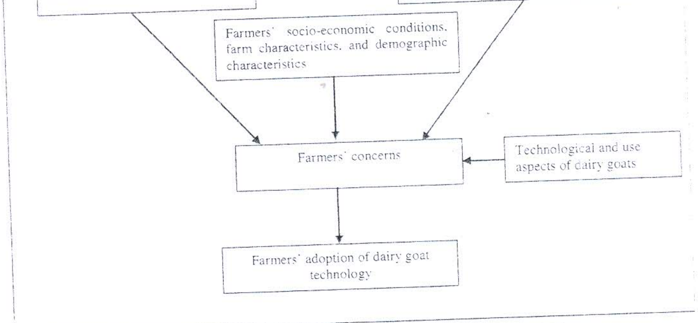
Conceptual Background

Past studies on adoption of technologies provide useful insights on household socio-economic characteristics, resource attributes, institutional factors, and level of adoption as some of the factors that influence the probability. In particular farmers' demographic and socio-economic characteristics have widely been shown to influence adoption of agricultural technologies in different developing countries (Feder et al., 1985; Adesina and Chianu, 2002).

Besides the effect of socio-economic factors, smallholder farmers have been shown to be rational and risk averse, and will only adopt technologies that meet their multiple concerns (Ellis, 1983). At the same time they will be constrained by the prevailing environmental factors such as the agro-ecological aspects, regional economic and cultural contexts, policy and governance factors such access to government extension services and credit services, and assistance from development agencies involved in promotion of agricultural activities (Rogers, 1995; Wale et al., 2005). (Fig 1.)

In reference to dairy goat technology, the technological concerns refer to dairy goats' responses to inputs such as feeds, management (husbandry) practices, in order to produce the expected outputs in a given farming system, while the use attributes denote the performance of a particular dairy goat breed for the purpose of utilizing it and its product in multiple ways such as sale of milk and kids and production of manure. The environmental factors are represented by rainfall, temperatures, pests and diseases and soil types which not only determine the agro-ecological zones (AEZ) favorable for dairy goat's production but also have a direct influence on production of fodder crops.

Figure 1: Factors influencing farmers' concerns and adoption of dairy goats



Source: Adapted from Wale et al., (2005) The various broad factors that influence farmers' concerns and adoption of dairy goat technology can be conceptualized as shown in Figure 1. It is hypothesized that characteristics of farmers' operational environment, external support services, and demographic, socio-economic and farm characteristics affect farmers' concerns and therefore the outcome of dairy goat adoption in the research area. It is depicted that farmers will only adopt the dairy goat technology if their concerns or interests are met. However these concerns are the outcome of the interaction of farmers' contextual socio-economic and demographic characteristics (e.g., age, farm size, family structure and gender, resource endowment, risk aversion, market opportunities, etc.), technological and use attributes (e.g. fodder, previous experience and use of the products), and several environment factors in the region where they live (Rogers, 1995; Batz et al., 1999; Adesina and Chianu, 2000; Fernandez-Cornejo and McBride, 2002; Wale et al, 2005). Ultimately, farmers' decisions to adopt dairy goat technology will determine its enhanced uptake in the research area.

There are other specific hypotheses that can be developed to test the relevance of the socio-economic and demographic as well as environmental factors. However since there are no adoption studies on exotic goat breeds in Kenya, most of these can only be generated from the above framework and literature on adoption of dairy cattle or indigenous dairy goats (e.g., Baltenweck and Staal, 2000; Staal et al., 2002). On the other hand, hypotheses to test the influence of technological aspects of the dairy goat technology can be based on Rogers' model (1995).

The Empirical Model and Hypotheses

Empirical Model

This study is based on the random utility theorem (Gujarati, 2003) which postulates that consumers (in this case farmers) will choose or adopt a technology which can maximize their utility. The decision to adopt a technology or not is a binary decision which can be represented as a qualitative variable whose range is actually limited since it can only take on two values (adopt or not adopt). An adopter in this study is defined as any farmer who had a pure dairy breed, a cross-breed or had a pregnant local goat which had been inseminated or served by a dairy breed buck at the time of the study. Thus adoption at the farm level describes the realization of farmers' decision to apply a new technology in the production process (Rogers, 1995).

Adoption decisions are usually analyzed using binary choice models (Ayuk, 1996). The binary models make use of the assumption that the farmer is faced with a choice between two alternatives; to adopt or not adopt a technology and that the choice made depends on attributes or characteristics described in this study.. Thus in the presence of a new technology, the farmer is faced with the decision to adopt ($Y=1$) or not adopt ($Y=0$)

$$Y = \beta_i X_i + \mathring{a} \qquad \text{... Equation-1}$$

Where, Y is the adoption decision, X_i represents the regressors and β_i is coefficients of the repressors. å is the random term (assumed to be identically, independently and normally distributed with $\mu = 0$ and variance $\acute{o}^2$.

The decision of the i^{th} farmer to adopt dairy goat technology depends on an unobservable utility index I_i (also known as a latent variable), that is determined by one or more explanatory variables in such a way that the larger the value of the index I_i, the greater the probability of a farmer adopting the technology (Gujarati, 2003). The index I_i is thus expressed as:

$$X_i = \beta_0 + \beta_i X_i \qquad \text{... Equation-2}$$

Where X_i are the set of independent variables?

It is assumed that there is a critical or threshold level of the index I_i such that if

$I_i > I_i^*$, the farmer will adopt ($Y=1$), otherwise if

$I_i < I_i^*$, the farmer will not adopt ($Y=0$).

Therefore, assuming normality, the probability that can be computed:

$$P_i=P(Y=1/X)=P(I_i^* \leq I_i)=P(Z_i \leq \beta_0 + \beta_i X_i)=F(\beta_0 + \beta_i X_i) \qquad \text{... Equation 3}$$

where $P(Y=1/X)$ means the probability that a farmer will adopt the technology given the values of the explanatory variables where Z_i is the standard normal variable, i.e. $Z \sim N(0, \acute{o}^2)$

Description of variables and hypotheses

As explained above, the explanatory variables (independent variables) used in this study include demographic characteristics, socioeconomic and farm (farming) characteristics, technological and use aspects, external support factors and environment factors. Their definitions and hypotheses are presented in Table 1. The dependent variable is DGADOPT (adoption of dairy goat technology). It is coded 1 if a household has any pure, cross-bred or a pregnant local goat inseminated by a dairy breed, and 0 if otherwise.

The rationale for selection of the above variables has been explained in the conceptual framework . Here-below, we only provide more information for a number of variables that need clarification as to why they were included in the model.

The number of local groups that the households belong to (GROUP_NO), is included in the model as a proxy for social capital. This factor has extensively been shown to enhance adoption of technologies in many developing countries (Grootaert, 2002). Notably, dairy goats were introduced in the research area through a group approach whereby farmers were requested to form dairy goats associations in order to access the exotic germplasm. We do not however include these associations in the variable (GROUP_NO) since joining them implied adopting dairy goats.

The FODDER_IN variable and EXPERIENCE in keeping local goats are proxies for the readiness of the farmers to use the technology. Indigenous fodder is normally grown in the research area as shrubs and trees to prevent soil erosion and to mark hedges and boundaries. Since dairy goats are usually zero-grazed, it is expected that farmers with such fodder trees will easily take up the technology as they have less feed problems. Likewise, farmers with extensive experience of rearing goats are expected to adopt dairy breeds without major difficulties.

Just like the EXTENSION and CREDIT variables, the MRKDIST factor is regarded as an external support service since it is the responsibility of the government to create markets through construction of roads and other infrastructures. Access to these support services is expected to positively influence adoption of dairy goats.

The DAIRYCOW factor is an indicator of favorable environmental factors for exotic dairy goat production just like the AEZ. Most areas in the Kenyan highlands

Table 1: Definition of Explanatory Variables

Variable	Definition	Hypothesis
Demographic characteristics		
GENDER	Sex of the household head (1=Male, 0=Female)	+
DEPEND_RA	Percent of household members below 14 years	+
Socio-economic and farm characteristics		
HHHEDU	Education level of the household head in years	+
GROUPS_NO	Number of formal and informal groups the household belongs to	+
FARMSIZE	Total farm size in acres	−
LABOR_TYP	Main type of labor used in the farm (0=Hired, 1=Family)	+
Technological and use aspects		
FODDER_IN	Whether the household grows indigenous fodder (1=Yes, 0=No)	+
EXPERIENCE	Number of years the household has been keeping local goats	+
MILK_CONS	Whether the household can consume goat milk if it is available (1=Yes 0=No)	+
Support services		
EXTENSION	Whether the household has been in contact with extension agents in the last one year (1= Yes, 0= No)	+
MRKDIST	Distance to the nearest market in Km	+
CREDIT	Whether the household has been able to access formal credit in the last one year (1=Yes, 0=No)	+
Environmental factors		
AEZ	Agro-ecological zone of the area (1=Upper Midland Zones, 0=Lower Midland Zones)	+
DAIRYCOW	Whether the household has dairy cattle (1=Yes 0=No)	+/−

where dairy cattle perform well are located in the Upper Midland and Highland agro-ecological zones where there are cool temperatures that the exotic dairy goat breeds are used to, though these are not any close to the temperate conditions in Europe. We therefore expect dairy goats to do well in areas with dairy cattle. However farmers with dairy cattle might also fail to adopt dairy goats because they are used for comparatively higher returns from cow milk and milk products. It is therefore difficult to predict the sign of this variable.

The empirical model derived from the variables in Table 1 is:

$$ADOPT\_DG = \beta_0 + \beta_1 GENDER + \hat{a}_2 DEPEND\_RA + \beta_3 HHHEDU + \beta_4 GROUP\_NO + \beta_5 FARMSIZE + \beta_6 LABOR\_TYP + \beta_7 FODDER\_IN + \beta_8 EXPERIENCE + \beta_9 MILK\_CONS + \beta_{10} EXTENSION + \beta_{11} MRKDIST + \beta_{12} CREDIT + \beta_{13} AEZ + \beta_{14} DAIRYCOW + \mathring{a} \quad \text{... Equation-4}$$

Equation 4 was analyzed using a probit model. The independent variables were assumed to have a normal distribution hence the Maximum Likelihood Estimation procedure (Gujarati, 2003) was used in the estimation of their coefficients.

Description of the Study Area

The study was conducted in Central and South Districts of Meru County which are located in the central Kenyan highlands. The central Kenyan highlands are on the slopes of Mount Kenya within the administrative boundaries of the Eastern and Central Regions. The two study sites are similar in many aspects including agro-ecological conditions, farming systems, population densities, cultural and economic activities. They were selected for this study because they had largest populations of dairy goats kept by smallholder farmers in all parts of Central Kenya region

Meru Central district lies to the North East of Mt. Kenya. It borders Laikipia to the West, Nyeri to the South West, Meru South district to the South, Tharaka to the East, Meru North to the North. It has an estimated total area of 3012 km^2 of which 2710 km^2 is arable land. Annual rainfall ranges between 500-2600mm while the altitude ranges from 600m a.s.l. in the lower semi-arid areas to 5200 m a.s.l. on Mt. Kenya (DAO, 2007). Meru South district occupies the eastern slopes of Mt. Kenya. It borders Embu to the South, Meru Central to the North West, Mbeere to the South East and Tharaka to the East. It covers an area of 1092.9 km^2 of which 360 km^2 is part of Mt. Kenya National Park and 185 km^2 is non-arable land. The mean temperatures range between 14° - 20° C, the annual rainfall ranges between 1250 mm to 2500 mm, while the altitude ranges from 500 m to 5199 m above sea level Kenya (MoLFD, 2006).

The two districts cover a wide range of agro-ecological zones from the Tropical Alpine Zone (TA) to Lower Midland Zones (LM) (Jaetzold & Schmidt, 1983) thus making it possible to experiment the favorable areas for dairy goat production. Dairy goats kept by farmers in the region are either crosses or pure breeds. The cross-bred goats comprise of either 50% or 75% Toggenburg genetic material (50% and 75% crosses respectively). Farmers obtain the 50% cross as a result of inseminating a local breed doe by a pure dairy breed buck. The resultant 50% female offspring (doe) is further inseminated by a pure dairy breed buck, raising its dairy genetic make-up to 75%. The 75% does are then crossed with 75% bucks to avoid raising the dairy genetic composition higher. This ensures that the traits from the local goat breeds (which include disease resistance and better adaptability to the local climatic conditions as compared to the pure dairy breeds) are not fully eroded.

The human population density in the two districts is high ranging from 450 to 700 persons per km^2 in some areas (Kariuki and Place, 2005). As a result, the area is characterized by small land sizes due to frequent land fragmentation. The area is characterized by complex farming systems dominated by perennial cash crops, food crops and livestock. The main cash crops produced for the export market are tea, horticulture, and coffee. Milk is sold locally to earn cash income but it is important for domestic use. The subsistence sector is dominated by the production of maize and beans

Data Collection Procedures

The study utilized primary data collected between June – July 2007. Two divisions in each of the study districts were purposively selected, the criterion being those with the highest populations of dairy goats. The selection of these divisions was also guided by key informant interviews which were conducted with the Ministry of Livestock & Fisheries Department (MoLFD), Farm Africa and Meru Dairy Goat Breeders Association and focus group discussions held with opinion leaders, contact farmers and farmer groups. From each division, two locations were then randomly selected. From these, 260 smallholder households were selected using the random walk sampling method. With this method every fifth household on the right and left hand side (alternately) of all the roads in the villages was randomly selected. A total

126 households were drawn from Meru Central while Meru South provided 134 households. This sampling technique was applied since it was not possible to obtain sampling frames of dairy goat adopters and non-adopters in the area. The sampled households were interviewed using a semi-structured questionnaire., and data on household, farm and livestock characteristics were collected.

Data coding, entry and cleaning was done with SPSS software. Descriptive statistics which included frequencies and cross-tabulations were generated with SPSS and used to characterize farmers' socioeconomic characteristics and practices. An econometric probit model was run using LIMDEP statistical software and used to identify the influence of various factors on the probability of adoption of dairy goats.

Results and discussion

Descriptive statistics of the sample households

The means and standard deviations of the dependent and explanatory variables are shown in Table 2. The sample households comprised of 46% adopters and 54% non-adopters. Farming is the main occupation of majority (68%) of the households while 19% of them are salaried workers. Majority of the sample households (86.5%) are male-headed with the mean age of the household heads being 50 years. Ninety percent of the household heads have at least basic education with the mean number of years of formal education being 7 years. The average household size is 4.5. More than half of the households (54%) have no title deed to their land due to frequent informal subdivisions. Majority of the households (74%) are married and living together with their spouses while the rest comprise of those married but with one of the spouses living away, single, separated/divorced and widowed.

Table 2: Descriptive statistics of the dependent and explanatory variables

Variable	Mean	Std Deviation
ADOPT_DG	0.46	0.50
Demographic characteristics		
GENDER	0.87	0.34
DEPEND_RA	28.32	22.61
Socio-economic and farm characteristics		
HHHEDU	7.40	4.10
GROUPS_NO	0.44	0.66
FARMSIZE	3.08	2.23
LABOR_TYP	0.34	0.48
Technological and use aspects		
FODDER_IN	0.37	0.48
EXPERIENCE	8.98	12.4
MILK_CONS	0.88	0.32
Support services		
EXTENSION	0.28	0.45
MRKDIST	2.83	2.10
CREDIT	0.12	0.32
Environmental factors		
AEZ	0.65	0.48
DAIRYCOW	0.61	0.49

Source: Own Data

Adoption of dairy goats

Forty six percent of all farmers in the sample had adopted diary goats while 47% of them had not. A small number of households (7%) had abandoned the dairy goat technology. This latter group is lumped together with the non-adopters in the analysis of the determinants of adoption. In Meru Central district, 47.5% and 45.5% were non-adopters and adopters respectively while in Meru South district, the two categories comprised of 47% and 46% respectively. In each of the districts, 7% of the households had abandoned the technology. Thus the two districts had similar trends of adoption of dairy goats.

Majority of the farmers (83%) in the two districts kept cross breeds while 17% had pure breeds of Toggenburg. In terms of genetic composition, farmers' herds comprised of different categories as shown in Table 3. When independent t-tests were conducted it was found that the compositions of farmers' herds in Meru Central and Meru South districts were not significantly different ($P<0.05$). The 50% cross, 75% cross and combinations of 50% cross and 75% cross were the three most important combinations in both districts. This is attributed to the method of acquisition of dairy goats. Instead of farmers buying pure breeds they were required to upgrade their local breeds by inseminating with imported pure dairy goat bucks. The later adopters could also purchase crosses from the early adopters who had upgraded their local breeds. The survey showed that majority of the farmers in both districts (89% and 96% in Meru Central and Meru South respectively) had acquired their dairy goats through these two methods. The rest of the farmers kept pure goat breeds in what was being termed as 'breeding farms'.

The stocking rate ranged from 1 to 15 cross-bred and/or pure breed goats per household. Majority (77%) of the adopters had a range of 1-3 dairy goats, with a mean of 2.91 and 2.69 dairy goats per household in Meru Central and Meru South districts respectively.

Table 3: Composition of dairy goat herds adopted by the farmers

Description of goats kept	Number of farmers		
	Meru Central (n=56)	Meru South (n=51)	Total (n=107)
50% cross only	12	16	28 (26%)
75% cross only	16	8	24 (22%)
Pure breed only	5	3	8 (7%)
50% cross + 75% cross	23	14	37 (35%)
50% cross + Pure	0	1	1 (1%)
75% cross + Pure	0	6	6 (6%)
50% cross + 75% cross + Pure	0	3	3 (3%)

Source: own data

Engendered adoption decision

The survey data showed that the decision to adopt dairy goats was made by men in 56% of the households, and women in 36% of the households, while in 8% of the households it was a decision undertaken jointly by the husband and the wife. This result implies that although women were actively participating in decision-making on adoption of the dairy goat technology, men played a more important role. However, the results are different when adoption stages - early and late - are considered separately. For the early adopters (1995 – 1999), more women (61.5%) than men (38.5%) influenced the decision to adopt dairy goats while for the late adopters (2000 – 2007), more men (58%) than women (32%) influenced the adoption decision. For the late adopters 10% of the households made the decision jointly unlike in the early adoption stage where there were no joint decisions. This implies that men may not have initially viewed dairy goats as an important income generating enterprise. However, with increased demand for kids and goat milk in the later years men changed this view so as to capture the highly visible benefits of rearing dairy goats.

Adoption of dairy goats across wealth categories

Three broad wealth categories (rich, middle and poor) were defined during focus group discussions with local leaders and farmers. Several wealth indicators such as major assets, type of housing, type of crop management, type of labour used, quantity of produce realized, and transport and communication facilities were used to categorize the households in the study area into the three wealth categories. Dairy goats were adopted across all wealth categories as shown in Table 4.

A higher proportion (52%) of farmers in the rich and middle wealth categories than in the poor category (29%) had adopted dairy goats. This may be due to the relatively high costs associated with acquiring insemination from exotic bucks since the variation in the study area. These results seem to contradict the popular belief that dairy goats are kept by the relatively poor farmers and are therefore referred to as the 'poor man's cow' (Saif et al., 2004). However this is not the case since the dairy goat's nickname 'poor man's cow' refers to the fact that the poor are not able to keep dairy cattle (not dairy goats) due to the high costs involved. Nevertheless, it is important to note that in all the categories more farmers keep dairy cattle than dairy goats (Table 4), probably because the dairy goat technology is still new in the study area. Those in the rich category are particularly able to adopt dairy goats as well as dairy cattle as compared to the other wealth categories since they have a higher purchasing power that enables them to access appropriate insemination services, feeds, drugs and other inputs required for these enterprises.

Factors influencing dairy goat adoption

The results of the probit model are presented in Table 5. The model correctly predicted 79% of the responses and the Chi-square value (111.10) is highly significant at less than 0.001%. The Psuedo R^2 is 31% which is within the range allowed with the kind data being analyzed in this study (Mbata 1997; Greene, 2003). The other model statistics are presented at the bottom of Table 5.

Table 4: Adoption of dairy goats across wealth categories

Wealth category of the household	Proportion of farmers (%)		
	Sample distribution	Adopters of dairy goats within wealth categories	Keepers of dairy cattle within wealth categories
Rich	16	52	88
Middle	56	52	60
Poor	28	29	47

Table 5: Probit results - factors influencing adoption of dairy goats

Variable	Coeff.	Std. Error	t-ratio
Constant	-2.172***	0.541	-4.012
Demographic characteristics			
GENDER	0.274	0.293	0.935
DEPEND_RA	0.009**	0.004	1.907
Socio-economic and farm characteristics			0.398
HHHEDU	0.038*	0.0264	1.446
GROUPS_NO	-0.176	0.153	-1.147
FARMSIZE	-0.076*	0.051	-1.494
LABOR_TYP	0.286	0.216	1.326
Technological and use aspects			
FODDER_IN	1.342***	0.199	6.755
EXPERIENCE	0.069***	0.014	5.018
MILK_CONS	0.399	0.320	1.249
Support services			
EXTENSION	0.411**	0.219	1.879
MRKDIST	0.037	0.046	0.808
CREDIT	0.002	0.020	0.118
Environmental factors			
AEZ	-0.152	0.247	-0.617
DAIRYCOW	-0.025	0.226	-0.109
Log likelihood function -123.74 | | Restricted log likelihood -179.29			
*Chi-squared = 111.10****			
Pseudo R^2 = 0.3098			
No. of observations = 260			
, ** and * = significant at 15%, 10% and 1% levels respectively*			

The probit model results show that except for social capital and AEZ variables all the other factors had the hypothesized signs. The coefficients of social capital and AEZ are however not significant and thus would not make sense to discuss them further.

Among the demographic characteristics the dependence ratio (DEPEND_RA) shows a significant influence on farmers' likelihood to adopt dairy goat farming. The positive coefficient of this factor indicates that households with larger numbers of children are more likely to adopt the dairy goats than those with smaller numbers. Since having more children in the research area implies being relatively poor, this factor supports the hypothesis that goats are pro-poor animals (Saif et al., 2004) and could play a role in alleviating poverty. The relationship between the goats and the relatively poor is also supported by the significant and negative coefficient of FARMSIZE in the socio-economic and farm characteristics category. This factor indicates that households with smaller farms have a higher propensity to adopt dairy goats than those with larger ones. As the relatively poor people also have smaller farms in the study area, this factor is also a proxy for poverty that lends support to Saif et al (2004).

The only other significant variable that has significant influence on adoption among socio-economic and farm characteristics is the level of education of the household head (HHHEDU). This factor positively increases the likelihood of adoption. This might be the case since more educated households are likely to understand the dairy goat husbandry techniques which are taught to farmers before they decide to take up the technology.

Among the technology and use factors, availability of indigenous fodder species in the farms (FODDER_IN) and the number of years the household had reared local goat breeds (EXPERIENCE) emerged as key variables that significantly and positively influenced the probability of dairy goat adoption. The importance of indigenous fodder as demonstrated by the probit results is also supported by the qualitative data collected during the survey. Farmers were of the view that unlike the local goats which could feed on many types of vegetations in the farms, the exotic dairy ones are adapted to feeds such as leaves and twigs of indigenous fodder trees. Hence farmers who have these indigenous fodder species growing in their farms are more likely to adopt dairy goats because they already have one input (fodder) readily available. Indigenous fodder grown by the farmers included *Lantana camara (27% of respondents)*, *Sepium elipticum (26%)*, *Croton macrostachyus* (16%) and *Ficus thonningii (15%)*. The significant coefficient of EXPERIENCE of keeping local goats had also the expected positive influence on the probability of adoption. This is an indication that this kind of experience provided farmers with some technology and use aspects of the dairy goats.

In the category of support services only access to EXTENSION services showed a significant influence on the likelihood of dairy goat adoption. As expected availability of general extension services positively influenced adoption since farmers had a chance to gather information on dairy goats when visited by extension personnel. Availability and accessibility of this information and knowledge on dairy goat technology might have contributed to enhanced adoption since farmers were able to reduce risks and also transaction costs associated with such an adoption process.

Conclusions and Policy Implications

This study made an attempt to estimate empirically factors that influence farmers' uptake of exotic dairy goat technology. The need of this research is justified by the fact that only about 50% of the farmers in the study area had adopted the technology, implying that there is still a good part of the local farmers to be convinced of keeping exotic dairy goats. The factors generated can therefore assist in prioritizing technology awareness campaigns and targeting farmers who are likely to adopt the exotic goats in the future. For instance future awareness campaigns on the importance of dairy goats are likely to yield better adoption results if they target households with relatively smaller farms and those with higher numbers of children. Such households are also likely to be among the relatively poor ones in the study area.

Education was also found to be an important factor which favors dairy goat technology uptake. This implies that adoption of dairy goats is compatible with policies promoting education in the study area. Thus, more farmers are likely to benefit from this technology if policy makers continue to enhance education programmes. Another factor that could also support adoption of dairy goats is the promotion of planting of indigenous fodder trees and/ or targeting farmers who already have this type of fodder. Similarly, targeting farmers with longer experience in keeping local goats is likely to favor adoption of the exotic dairy breeds and their crosses. However, it is important to note that enhancement of production of indigenous fodder trees may not be so important in the short term since these trees usually take at least 3 years to grow.

This study has also shown that the role of extension services in enhancing adoption of dairy goats cannot be underrated. Thus government extension programmes in the study area could be enhanced to accelerate adoption of the exotic dairy goats. As extension officers go to farmers with a package of messages for different enterprises, enhancement of this factor is likely to benefit agricultural production as a whole even as it increases the likelihood of dairy goat technology uptake.

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Tobacco plants may be new incubator for vaccines for flu – or bio-terrorism

A $21-million-dollar infusion from the U.S. Defense Department's research arm will help a Canadian company set up a manufacturing plant to incubate flu vaccine in tobacco leaves. Medicago Inc., a Quebec City-based biotech firm, is setting up an 85,000-square-foot facility in Durham, N.C., to manufacture 10 million doses of flu vaccine a month using their new technology. A five-week-old Australian tobacco plant, which does not have nicotine in it, is put in a solution that is full of a bacteria that carries a genetic code for the DNA for the vaccine. The leaves and solution are put in a steel tank and a vacuum is created. The plants then absorb the information that is carried in the solution. But it's not just the battle against influenza that concerns the United States' Defense Advanced Research Projects Agency, prompting it to fund work at Medicago. One of the things that the Quebec firm's technology could be used for is vaccines or antidotes for biological terrorism or warfare. Meanwhile, Medicago's Quebec plant is completing clinical trials on an avian flu vaccine also made using tobacco plants.

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