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Full Length Research Paper

Analysis of factors affecting dairy goat farming in Keiyo North and Keiyo South Districts of Kenya

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Dairy goat milk production is undertaken in traditional extensive production systems with limited resources and harsh climatic conditions. Less attention has been given to goat milk and related products to minimize poverty food insecurity. The main objective of this study was to analyze the factors of production for dairy goat farming. It was hypothesized that farmers' factor inputs do not significantly impact on the output of the dairy goat farm enterprise. The study was carried out in Keiyo District of Kenya using a sample of 100 farmers. Multistage,Purposive and Simple random techniques were used. Cobb-Douglas production model,marginal value product and marginal factor cost were used for computations. The findings of the study revealed that the factors of production analyzed had a significant impact to the total output produced. It was established that land under dairy goat, cost of disease and pest were significant. Policy recommendations towards adequate land under dairy goats and improved management practices aimed at cheaper and effectively utilized inputs may be a priority for the dairy goat industry.

Key words: Goat farming, dairy goat milk, production, factors.

INTRODUCTION

FAO (1991) estimated the world population of dairy goats to be over 590 million, where countries in Europe and around the Mediterranean region have the most developed dairy goat industry and dairy goat-focused research. In less developed countries, goats are sometimes referred to as the poor people's animal and are primarily owned by smallholder farmers mostly nomads where they contribute the major income that significantly affects the economy and food supply of the poorest sectors of the society. Kenya was ranked 20th among the world leaders in goat milk production and the fifth largest producer in Africa (FAO, 1991). Goats form an integral component of the livestock enterprise in Kenya with an estimated population of 10.7 million (GOK, 2002) and spread in all agro-ecological zones of Kenya. Goats are reared to provide meat, milk, hides and manure, and are easy to keep and feed (Nyendwa, 2002). There are two main indigenous breeds in Kenya; the East African and the Galla. Both breeds are kept mainly for meat production.

However, the Galla is milked by the local farmers and has been known to produce up to 2 L daily. The main dairy breeds reared in the study area are the Alpines and the Toggenburg breeds. The Alpine breeds are estimated to be over 95% in number. This breed was identified to be a cross breed between the German Alpine and Kenyan Alpine. Toggenburg breeds are present but constitute less than 5% of the total dairy goat population. On average, a dairy goat is capable of producing 2 L of milk daily but due to lack of proper feeding and husbandry, production can drop to below 1 L. Interest in the value of goats as domestic livestock is presently widespread in the region. Its importance has been identified by the wide recognition of their role in food production as well as other economic importance in the tropics and sub-tropics where they are concentrated forming an important component of traditional farming systems (Devendra, 1985). The nutritional benefits of goat milk are also aiding the takeoff of the enterprise. Hospitals give the milk to AIDS (acquired immune deficiency syndrome) patients to help reduce their viral counts. The milk is recommended to the patients because its high protein molecules are better absorbed than other proteins, therefore they are known to strengthen their antibodies.

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Also, for mothers who opt not to breast feed, the milk is an ample substitute. Kinyanjui et al. (2010) studied the socio-economic issues of the dairy goat in Kenya and revealed that about 57% of the milk produced was consumed in the household. Thus, dairy goats enable households to access milk especially for the children, the sick and the old. Surplus milk is sold despite the little amount of goat milk produced. They were also able to establish that the farm gate prices for the milk ranged from Kenya Shillings 120.00 to 150.00 per liter in hospitals, hotels, church congregation and dairy processors who purchase goat milk for making cheese formed the dairy goat milk market in Nairobi. Goats are particularly important animals in subsistence agriculture and accounts for their unique ability to adopt and maintain themselves in dry and harsh environments. Keiyo district is partly semi arid and occasionally faces very severe food insecurity due to weather changes and scarce resources. The dairy goat is very important because it requires fewer resources to maintain than the dairy cow in this region. The main objective of this study was to evaluate the economic factors in dairy goat farming by analyzing the factors of production employed in the dairy goat industry.

Statement of the problem

Dairy goat production has been gaining popularity in many countries of the world in the recent years and among the small-scale farmers, as it does not require large areas to keep them, as well as the increasing demand for goat milk due to its unique and equally important nutritional value. Smallholder farmers in Kenya are increasingly turning to dairy goat rearing in some regions as a means to grow incomes while improving nutrition in rural areas, as well as commercial benefits of goat dairy products (DGAK, 2009). However, dairy goat milk production has not gained much popularity in other parts of Kenya among some communities due to issues perceived to include cultural perception, lack of information on production, marketing and consumption as well as great preference of alternative dairy milk products, especially the cow's milk.

Unfortunately, the costs involved in successful dairy cow milk are far beyond the ability of most small scale especially in Keiyo district. The situation observed in the study area is a decline in the adoption of dairy goat farming, soon after it was introduced in the region. DGAK (2008) reported that some initiated projects have been established in major dairy goat production areas such as Central, Eastern and Nyanza Provinces in Kenya that have enabled farmers to double their farm income from goat milk through the introduction of improved dairy goat. It was observed that the demand for dairy goat milk and related products have outstripped the corresponding supply. It was further identified that there exist an export market for goat cheese and local demand for goat milk and yoghurt and that there exist certain level of goat milk that does not reach the market. The potential opportunities from the dairy goat enterprise to alleviate poverty and food insecurity can be realized. It is against this background that this study is set to investigate bottlenecks associated with the factors of production employed by the dairy goat farmers.

Objectives of the study

The main objective was to analyze economic factors in dairy goat farming.

Specific objectives

To analyze the factors of production employed in the dairy goat milk.

Hypothesis

H_O: Farmers' factor inputs do not significantly have an impact on the output of dairy goat milk in Keiyo district of Kenya.

RESEARCH DESIGN

The study adopted a descriptive survey method. The descriptive analysis approach was considered ideal for the study, because it sought to gain insight into a phenomenon as a means of providing basic information in the area of study. It provided quantitative and qualitative descriptions of some parts of the population that described and explained the larger population (Bless and Higson-Smith, 2000).

Target population

The study population comprised of farmers or household families who are engaged in dairy goat rearing in the entire study area. According to GOK (2009), it was estimated that Keiyo District goat population is 64,000 whereas the dairy goat population is 719. On average, it was also estimated that each dairy goat farmer reared an average of two goats giving rise to a study population of over 360 farmers. Thus, the study population targeted 360 goat farmers or household families who are engaged in dairy goat farming from the study area. The respondents from the target population was purposively selected after considering factors such as accessibility and the significance of the study information from the farmers and other stakeholders to be collected.

Sampling procedure and sample size

Three sampling techniques; multi-stage, purposive and simple random sampling techniques were used to select 100 farmers who formed the sample. According to Mendenhall and Sincich (1995), the sample size whose population is greater or equal to 30 is relatively well represented for a well-defined survey.

Primary data and sources

The study utilized data from primary sources which was obtained using questionnaires, interviews schedules and observations. The characteristics of the primary data comprised of background information, age of respondents, gender, and marital status, highest qualifications of education and among other data related to the research objectives.

Secondary data and sources

Secondary data that informed this research included the divisional report on goat farming at relevant divisions, District development plans, National Development Plan document, policy documents, session papers, books, journals and articles and acknowledged authorities within the study area.

Instruments for data collection

Questionnaires, interview schedules and observations were used to collect the data.

Theoretical framework

This study was guided by the theory of the firm which assumes that a firms' primary objective is to maximize profits. In maximizing profits, firms' are subject to two constrains; the consumers demand for their products and the cost of production.

Derivation of production functions

Expression (1) is a specification of a production function relevant to a case of livestock production.

$$Q=f\{L, R, K\ldots\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where Q represent a firms output, L may represent the amount of labor used, R represents value of land rent used in production of Q, while K represents the amount of feeds used. The objective of the producer is to maximize profit either by increasing the quantity of Q produced or by reducing the cost of producing Q. The production function shows the maximum amount of the good that can be produced using alternative combinations of labor (L), land (R) and feeds (K). Q is also referred to as the total physical product (TPP). This production relationship can be expressed in several forms such as; linear functional forms, polynomial functional forms and Cobb-Douglas in an exponential functional form. The later is modified into the transcendental and translog functional forms. The marginal physical product (MPP) of an input is the additional output that can be produced by employing a unit of that input while holding all other inputs constant. An example of the MPP of labor is given as follows;

$$MP_L = \delta Q/ \delta L = f_L \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (2)$$

This is the first derivative of the production function with respect to labour. However, if labor is employed indefinitely while holding all the other inputs of production, this results into diminishing marginal productivity where the rapid increase in use of additional input results to lower productivity. Therefore, the second derivative is less than zero;

$$\delta MP_L/ \delta L = \delta^2 Q/ \delta L^2 = f_{LL} < 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

The elasticity of supply of an input measures how an output responds to changes in inputs. In a Cobb-Douglas production function, the sum of elasticities gives information about the returns to scale, that is, response of output to a proportionate change in the input gives the value of the returns to scale parameter. A sum equal to 1 indicates a constant return to scale. If the value is lower than 1, then there are decreasing returns to scale whereas greater than 1 implies that there are increasing returns to scale.

Measuring the efficiency in dairy goat resource use

In order to measure the efficiency in resource use, APP was first obtained using the formula

$$APP= Y/ X_i= Output/ Input_{Xi},$$

where the factor inputs that were used to analyze profitability are X_{i1}, X_{i2}, and X_{i5} which forms a component of variable costs in production. Secondly, the elasticities of the factor inputs were obtained from the multiple regression analysis for the corresponding inputs. MPP was then obtained using the formula

$$MPP = APP \times \text{Input elasticities}$$

Finally, MVP was obtained by multiplying MPP with the unit price of the output (that is $MVP = MPP \times P_Y$). The input prices were obtained from the previous analysis to be compared with the MVP in order to interpret the

Table 1. Descriptive statistics of production quantities.

Respondent's dairy products	Min	Max	Mean	Std Deviation
Goat Milk sold (litres)	1.0	5.5	2.7	1.13
Milk sold from cows (litres)	0	15.0	5.9	3.70
Goat stock sold (Number)	0	3.0	1.0	0.66

Source: Survey data, 2010.

efficiency of the resources used.

Profitability evaluation

The dairy goat milk profitability was estimated using notation presented by Heady and Dillon (1961) expressed in Equation (4) as follows;

$$Profit\ (\pi) = P_y Y_i - \Sigma P_{Xi} X_i - F \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where π = Profit, P_y = Unit price of output, Y_i = Amount of physical output, P_{Xi} = Market price of input X_i , X_i = Amount of the ith factor input, F = Value of the fixed costs - whenever appropriate, X_i $(i = 1\text{-}7)$ are fodder feeds (kg), feed concentrates (kg), mineral salts (kg), other feeds (e.g. banana leaves, sacks of natural pasture/ shrubs, acacia pods bought etc) (kg), labor (number), transportation (number), disease and pest control (number) and breeding frequency (number).

Summary of production quantities

Most of the farmers in the study area use the milk they produce from the dairy goats for their own domestic consumption. It was estimated that more than 75% of the total milk produced was not sold to the formal market. The products sold to the market were noted to be goat milk and the goat stock. Cow milk products were included for comparison purposes. Table 1 presents the descriptive statistics pertaining to production quantities produced in the study area.

Summary of product prices

All respondents interviewed revealed that there is no dairy goat milk processor in the entire study area. In other developed dairy goat producers in Kenya such as in Meru and Nyeri regions, farmers through their associations are able to process their milk into products such as fresh milk, sour milk (*mala*) and yoghurt brands. In more developed markets, it is possible to produce butter and ghee from the dairy goat milk (DGAK, 2008). There exists a market for the goat milk in the study area. Some respondents acknowledged selling their milk to Academic Model Providing Access To Healthcare (AMPATH), a medical institution located at Eldoret town affiliated to Moi Teaching and Referral Hospital dealing mainly with AIDS patients and related research, at a price of between KShs. 100.00 and KShs. 120.00 per litre. Goat milk is said to be very important to their patients and their research on patient drugs due to its medicinal value.

Moreover, it is believed that goat milk could assist in developing a vaccine against AIDS virus. Similar potential markets could also be present for institutions such as Eldoret Hospital, Uasin-Gishu District Hospital, Mediheal Hospital, Hospice Hospital and Iten District Hospital. However, neither farmers nor concerned dairy goat associations have exploited this opportunity. Local markets for dairy goat milk also do exist. This was observed in two main ways. Firstly, farmers sell their milk to special demand from specific individuals mainly suffering from ailments such as diabetes. The second category of market is from local individuals who buy the milk for their own domestic consumption. For either of this market, the selling price of the milk is between KShs. 50.00 and KShs. 60.00 per litre. In this study, the selling prices of goat milk and the goat stock were collected for evaluation. The selling price of dairy milk from other livestock was also collected and was used to make comparison and derive its impact to the marketing of the dairy goat milk. Table 2 presents the descriptive statistics pertaining to the market selling prices of the products produced by the respondents in this study.

Goat farming factor production

In order to assess the goat farming factor production, the goat milk production function was estimated using the Cobb-Douglas production function employed. Multiple regression analysis was then used to analyze the data and the results are shown in Table 3. The combination of the independent variables (cost of labor inputs, units of feeds, land under dairy goat farming, number of dairy goat stock, and cost of disease control) accounted for 94% variation in total output (adjusted R^2 – 0.94). The results showed that the independent variables were significant and there existed a casual relationship of the variables ($F = 85.558$, $P < 0.005$). Based on the coefficient results shown in Table 4, the estimated regression model to determine the goat milk output in the

Table 2. Descriptive statistics of products' prices (Kenya shillings).

Respondent's dairy products	Max	Mean	Std deviation
Goat milk (Litres)	90.00	54.15	16.97
Other livestock milk (Milk from cows) (Litres)	35.00	26.00	10.59
Goat stock (Number)	8,000.00	4,722.00	2,685.03

Source: Survey data, 2010.

Table 3. A Joint contribution of the independent variables.

Source of variation	Df	Sum of squares	Mean of squares	F- ratio	P
Regression	5	4.971	0.994	85.558	0.000
Residual	22	0.256	0.012	-	-
Total	27	5.226	-	-	-
Multiple R			= 0.975		
Multiple R^2			= 0.951		
Multiple R^2 (Adjusted)			= 0.940		
Standard Error of Estimation			= 0.108		

Source: Survey data, 2010.

Table 4. The coefficients of the regression model.

Coefficient	Un-standardized coefficients B	Std. error	Standardized coefficients Beta (β)	T	Sig
Constant A	-5.56	1.664		3.346	0.003
Ln X_{i1}	0.620	0.224	0.295	2.769	0.011
Ln X_{i2}	0.177	0.124	0.181	1.421	0.169
Ln X_{i3}	0.353	0.055	0.441	6.430	0.000
Ln X_{i4}	0.393	0.073	0.447	5.369	0.000
Ln X_{i5}	0.403	0.070	0.378	5.790	0.000

Source: Survey data, 2010. Dependent variable: Ln Y_i.

study area was expressed. Land under dairy goat was the most significant and potent contributor to the total output (β = 0.441, t = 6.430, P<0.05). This was followed by cost of disease and pest control (β = 0.378, t = 5.790, P<0.005), number of dairy stock (β =0.447, t = 0.536, P<0.005 and cost of labor inputs (β = 0.295, t = 2.769, P<0.005). Units of the feeds was the least contributor to the total output (β = 0.181, t = 1.424, P>0.005).

Furthermore, the signs and values beta (β) illustrate the correlation and elasticities of production of the independent variables. Since all the beta values were positive, it implied a positive correlation of the independent variables whose impact leads to an increase in the value of the dependent variables. These elasticities showed the percentage change in the dependent variables when an independent variable is changed (holding other independent variables constant). The results therefore show that a 1% increase in the cost of labor would lead to 0.295% in total output. Similarly, a 1% increase in the units of feeds used would lead to 0.181% increase in the total output; a 1% increase in land would lead to 0.441% increase in the total output; a 1% increase in the number of dairy goat stock would lead to 0.447% increase in total output; and 1% increase in the cost of disease and pest control would lead to 0.378% increase in total output. The sum elasticities (β_i) give information about the returns to scale, that is, the response of output to a proportionate change in the input used. In this study, adding the five input elasticities analyzed gave a sum value of 1.946. Since it is evident in this study that the sum is greater than 1, it reveals that the dairy goat production is characterized by increasing returns to scale, thus doubling the inputs will more than double the output.

SUMMARY OF THE FINDINGS

The study established that despite the farmer's average size of the farm being 1.089 ha, only 0.186 Ha on average was set for goat grazing. The average age of the farmers was 39 years and that daily milk production was 2.7 L. This suggests that the youth tended to shun dairy goat farming. These findings are consistent with the findings of Armagan and Ozden (2007), who found out that demographic factors of farm size and labor increase the total factor productivity (TFP). Thus, gross production value increases by the increase in labor in small farms, land size in medium farms and variable inputs in large farms. These views support those by Murithi (1990), that if the amount of resource use is increased, then there should be substantial increase in milk production. The finding that the area set for goat browsing/grazing was very small tends to lend support to the findings of FARM-AFRICA (1996), that due to increasing population pressure in areas with a mixed crop-livestock farming system, free grazing is becoming limited and goats are now tethered. This reflects the challenge of procuring sufficient feed, which in turn leads to poor milk and stock returns. Regarding the cost of inputs, the study established that feed accounts for the main cost of goat milk production. It was established that apart from natural pasture, which is freely available, many other supplements, which are rather costly, are necessary for balancing the diet to meet the nutrient requirements. The study established that among other supplements, fodder feeds averaged a cost of KShs. 7.80; feed concentrates averaged a cost of KShs. 83.10; mineral salts averaged KShs. 14.60; and other supplements averaged KShs. 157.60 per month. These costs coupled with the fact that an average of only two goats was milked daily tended to be prohibitive.

Furthermore, the study established that other than feed supplements, labour, transportation and disease and pest control were also costly. On average, hired labour was KShs. 890.00 per month. Milk transportation and disease and pest control cost an average of KShs. 179.00 and KShs. 175.40 per month respectively. These findings are consistent with the findings of Onim (1992) that constraints in smallholder dairy goat farming were evident and translated to difficulty in achieving high levels of performance. Farmers tended not to follow recommended regimes for feed supplementation and routine disease management practices due to high costs normally associated with concentrates and drugs. Consequently, it is possible that most farmers were not able to purchase basic dairy goat inputs. The results showed that cost of labor inputs, units of feeds, land under dairy goat farming, number of dairy goat stock, and cost of disease control were significant and accounted for 94% variation in total output. Policy recommendations to alleviate poverty and food insecurity in semi arid Kenya, using the dairy goat should target these variables.

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