Determinants of Small Holder Dairy Farmers Milk Production and Supply to Market in Uasin Gishu County, Kenya

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Abstract: **- This study aimed at analyzing the determinants of small holder dairy farmers' milk production and supply to market in Uasin Gishu County, Kenya. A Cobb Douglas production function was used to determine the factors influencing the quantity of milk produced while a supply function was used to determine factors influencing the quantity of milk marketed. Results of this study indicated that farmers are doing dairy farming for commercial purpose (79%) which is a clear step towards improving productivity and marketing. Factors which significantly affected milk production included milk price, training on animal husbandry, access to AI services, total farm size and group membership whereas sex of household head and the duration of keeping dairy cattle did not significantly influence milk production. The variables which significantly influenced the quantity of milk sold to the market were amount of milk produced and amount of milk consumed at home whereas household size and average price of milk did not significantly affect amount of milk supplied to the market. Given the results of this study the government should invest more in dairypolicies geared towards price stabilization, provision of AI services and training on dairy farming. Farmers should also be encouraged to join farmer dairy groups.**

Key words: **Cobb-Douglas, Commercialisation, Demand, Milk productivity, Market, Supply**

Contribution/Originality

This study coveredsmall holder dairy farmers in Uasin Gishu County to evaluate the determinants of milk production and supply to market. The study identified the major factors influencing the production of milk and its supply to the market in the study area. Researchers and policymakers can use the findings of this study to enhance milk productivity and dairy product commercialization in milk producing areas in Kenya.

I.INTRODUCTION

A general agreement exists that agriculture is the cornerstone to economic growth in the countries of sub-Saharan Africa, contributing about 70% of total employment and over 30% of GPD (Rahman and Manprasert, 2006) [1]. Nearly 80% of Kenya's population of over 40 million live in the rural areas where three quarters engage in agricultural activities (GOK, 2009) [2]. The Livestock sector alone contributes 10 percent of total GDP and 30 percent of agricultural GDP, out of which the dairy sub sector (excluding live animals) contributes 4% GDP and 30 percent of livestock GDP (FAO, 2011) [3]. Smallholder dairy in Kenya is one of the most successful in Africa (Staal*etal*., 2008) [4].Commodity production and trade have substantial bearing on sustainable livelihoods of the poor, as well as on the exports and growth of a number of commodity-dependent developing countries.

Kenya's dairy production is largely smallholder. According to Conelly 1998, [5] it was not until 1954 after the Swynnerton plan that the native population were allowed to engage in commercial agriculture. By 1963, when Kenya attained independence, the dairy herd had increasedto about 400,000 exotic cattle largely in the hands of the settlers.Smallholder dairy farmers produce over 80% of the marketed milk with production concentrated in Central and the Rift valley regions. The productivity per animal is however lower than the global leaders like the EU countries, USA, South Africa and New Zealand (Staal et al, 2008) [4].

Kenya's vision 2030 objects to transform the agricultural sector comprising the dairy sub sector from subsistence to a marketable direction to achieve 10% annual economic growth in order to address the difficulties of low productivity and commercialization (GOK, 2009) [2]. Commercial transformation of subsistence agriculture is a vital trail towards economic growth for many agriculture dependent developing economies including Kenya (von Braun et al., 1994 [6]; World Bank, 2008 [7]).

1.1 Research Problem and Objective of the Study

Commercialization and enhanced market access are vital for enhancing the incomes of rural farmers. Smallholder market involvement is greatly influenced by factors of production along with transaction costs. Key et al., (2000) [8] suggested that high transaction costs is one of the major causes that make smallholder farmers not to take part in markets and supply the right amount of produce.

Distance to point of sale, source of information, and cost of transport from farm to market and geographical locality of the farm/household are correlated to the amount of transaction costs farmers will face at the market (Abdulai and Birachi 2009 [9] and Ouma et al., 2010) [10].

Existence of transaction costs regularly leads to farmer exploitation by middlemen/brokers by taking advantage of small-scale dairy farmers by charging lower prices per unit output hence reducing profit margins. The prospective for milk to contribute to rural farm households' source of revenue is not likely to be realized if the impedimenta are not addressed in earnest. This paper thus evaluates the main factors affecting the amount of milk produced and sold to the market by small-scale dairy farmers in Uasin Gishu County, Kenya.

1.2 Overview of the dairy industry in Kenya

The dairy processing industry in Kenya comprises of large, medium and small scale processors. Until the 1990s, the Kenya Creameries Corporation (KCC) processed all the milk in Kenya, but its monopoly slowly decreased between 1993 and 1996 (Olok-Asobasi and Sserunjogi, 2001) [11]. Regardless of liberalization and restructuring of the dairy sector, political interventions, inefficient management and political rent-seeking behavior led to the downfall of KCC as a state monopoly in the 1990s. Subsequently, the end of government monopoly status of KCC encouraged private sector participation through other large-scale processors. Many private processors joined the dairy business in 1992, and have increased greatly since 1999. According to the industry statistics by the Kenya Dairy Board, in 2010, there were an estimated 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars.

Over the last few years, milk processing in Kenya has been controlled by three main processors, namely, the New KCC, Brookside Dairy Limited and Githunguri Dairy Farmers Cooperative and Processors. The three processors command a large market share, in an industry with about 27 processors. Even though Kenya's dairy sector has a significant contribution to the national economy, household incomes and food security, the industry faces a number of technical, economic and institutional problems in milk production, processing and marketing (Karanja, 2003) [12]. These constraints affect the ability of the sector to participate and compete in the domestic and regional markets.

Specifically, some of the main constraints to increased milk production in Kenya have been identified as seasonality in production, inadequate quantity and quality of feed, including limited use of manufactured cattle feeds, and lack of good quality animal husbandry and farming practices. Poor access to breeding, animal health and credit services and high cost of artificial insemination (AI) service are other constraining factors. In some areas, dairy producers are faced with the problem of poor infrastructure (roads, electricity), inadequate milk collection and marketing system, poor interaction and priority setting between research, extension and training, and limited farmers' involvement in the output market, hence reducing the incentives to increase milk production (SDP, 2005) [13].

Milk processing and marketing on the other hand is limited by several factors. Primary marketing faces infrastructure bottlenecks caused by poor road networks and lack of appropriate cooling and storage facilities. The poor road infrastructure in the small-scale production areas affects the transport of milk from farms to the collection centres, and subsequently from the collection centres to the processors. The lack of electricity in most areas has limited the establishment of cooling plants. As a result, particularly during the flush period of March to June, there is surplus milk that cannot be absorbed in the domestic market.

II. MATERIALS AND METHODS

2.1 Study Area

The study area is Uasin Gishu County. It lies between longitudes 34 degrees 50'' to the east and 35 degrees 37'' to the West. It lies latitudes 0 degrees 03'' to the South and 0 degrees 55'' to the North. The county Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Baringo County to the South East, Kericho County to the South, Nandi County to the South West and Kakamega County to the North West. With a total area coverage of 3,345.2 Sq. Km(Uasin Gishu County CIDP, 2017) [14].

2.2 Sampling Procedure

The sample size was determined using the formula by Cochran (1977) [15]. Cochran developed a formula to calculate a representative sample for proportions as:

$$n_0 = \frac{z^2pq}{e^2} = \frac{(1.96)^2}{0.05^2}(0.9)(0.1) = 138$$

Where, $n_0$is the sample size (138), z is the selected critical value of desired confidence level, p is the estimated proportion of an attribute that is present in the population i.e. the proportion in the target population estimated to have characteristics being measured (The smallholder dairy farms contribute over 80% of the marketed milk output in Kenya (Muriuki, 2001) [16],$q = 1- p$ i.e. the proportion in the target population estimated to having no characteristics being measured and e is the desired level of precision. A multi-stage stratified sampling procedure was used to select sampling units. In the first stage, purposive sampling was used to select three Sub-Counties i.e. Ainabkoi, Kapseret, and Turbo and two wards in each Sub County that are highest milk producing areas. Simple random sampling was used in the second stage to draw a sample of 138 dairy farmers according to probability proportional to size.

2.3 Data Collection Technique and Analysis

Primary method of data collection using a structured questionnaire was adopted in this study. This was realized with pre-tested survey questionnaire administered to the sampled respondents. Well-trained research assistants assisted in data collection. The interview schedule covered a series of questions including social-economic characteristics of households, cropping and farming characteristics, production estimates, farm-gate and market prices. Parameter coefficients were estimated using SPSS software, version 20.

2.4 Model Specification

Econometric Model: In economics, the Cobb-Douglas functional form of production functions is widely used to represent the input-output relationship and it appears to be a good approximation to actual production (Romer, 2001) [17]. A revised Cobb Douglas production function was used to determine factors affecting quantities of milk produced by farm households, while a supply function was used to evaluate the factors affecting the quantity of milk sold to market by farm households. A Cobb Douglas function estimates elasticity of production and marginal productivity of critical factors of production. The common Cobb-Douglas production function model is provided in Equation 1:

$$\Pi_i = (\lambda_0) * (\beta_1^{\alpha 1}) * (\beta_2^{\alpha 2}) * (\beta_3^{\alpha 3}) * (\beta_4^{\alpha 4}) * \ldots * (\beta_n^{\alpha n}) \ldots\ldots\ldots (1)$$

Where $\Pi_i$is quantity of milk, β is a vector of inputs/resources with j= 1, 2, 3….n, λ is the constant and α_k are the parameter estimates with k=1, 2, 3, 4….n; that estimate the elasticity of transformation ratios for the inputs β. Equation 1 was transformed to a natural logarithmic linear function (Equation 2) to enable for the interpretation of the constant and coefficients in elasticities. The Cobb-Douglass production function has some desired characteristics that make it more suitable for this study. These include the use of α_k to estimate the partial elasticity of milk output with respect to the inputs that is. It measures the percentage change in that particular input *ceteris paribus.* The quantities of milk produced could therefore be deduced using these parameter estimates.

The outputs of milk produced can hence be inferred using these parameter estimates. It is possible to computer the returns to scale, i.e. theresponse of Π to a proportionate change in inputs (Gujarati, 2004) [18].This could also be used to elucidate the dynamics affecting the quantities of milk produced in Equation 2.

$$Ln\Pi i = ln\lambda + ln\alpha_1\beta_1 + ln\ \alpha_2\beta_2 + ln\ \alpha_3\beta_3 + ln\ \alpha_4\beta_4 + \gamma_1\theta_1 + \gamma_2\theta_2 \ldots \gamma_4\theta_4 + \epsilon_i \ldots\ldots\ldots (2)$$

Where: Π =total output (milk) produced, λ = model constant, β_1 = total farm size, β_2, = Market price of milk, β_3 = total farm size under dairy, β_4 = duration of keeping dairy cows, θ_1= sex of respondent (dummy 0 = male, 1 = female), θ_2= Group/association membership (dummy 0 = No, 1 = Yes), θ_3 = Access to extension service (dummy 0 = No, 1 = Yes), θ_4= Access to training on animal husbandry (dummy 0 = No, 1 = Yes) and ϵ = disturbance term.

A supply function was used to determine the factors affecting the quantity of milk marketed. Since milk has other alternate uses such as home consumption, consumption by calf and others given to workers meaning that all that is produced is not sold, this made the supply equation more suitable. The supply function was specified as follows:

$$LnYi = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 X_5 + \mu_i \ldots\ldots\ldots (3)$$

Where β_0 = Model constant, Y_i = Quantity of milk marketed (liters), X_1= Quantity of milk produced (liters), X_2 = Quantity of milk consumed (liters), X_3 = Quantity of milk given out (liters), X_4 =, Price of milk per liter X_5 = Household size (persons)

III. RESULTS AND DISCUSSION

3.1 Collinearity Diagnostics

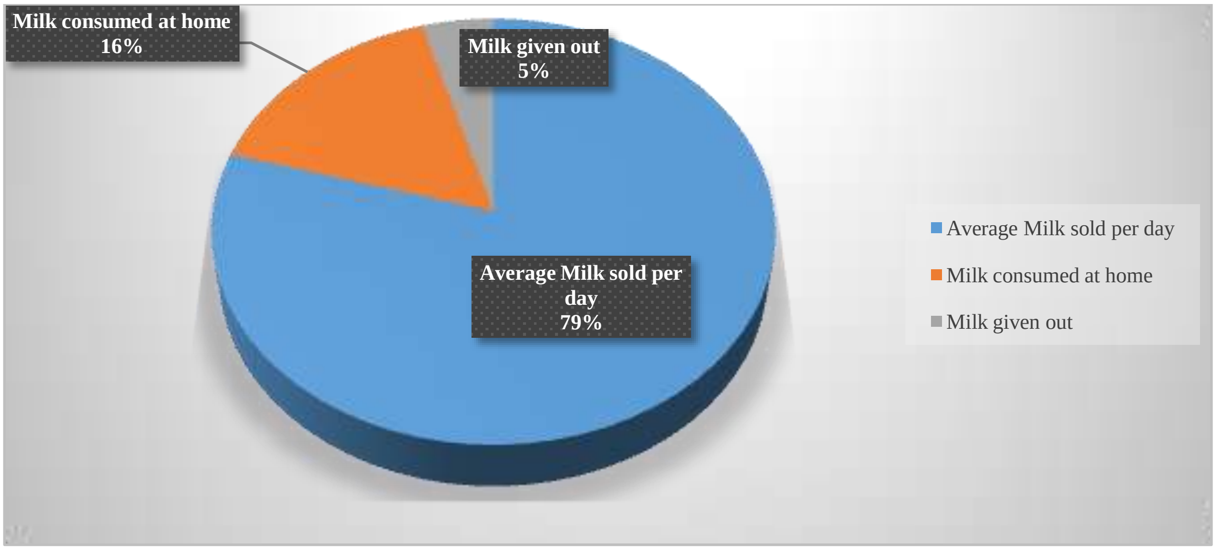
Collinearity diagnostic tests were done using a simple regression matrix of the variables. Variance Inflation Factor (VIF) was used to check for tolerance level of multi-collinearity. As per Gujarati (2004) [18], the average VIF of less than 10 implies that the variables in the model have no serious multi-collinearity. Durbin Watson test (DW) was also used to test for the presence of serial autocorrelation.The DW test reports a test statistic, with a value ranging from 0 to 4, where; 2 is no autocorrelation, 0 to <2 is positive autocorrelation (common in time series data) and >2 to 4 is negative autocorrelation (less common in time series data). A rule of thumb is that test statistic values in the range of 1.5 to 2.5 are relatively normal. Values falling out of this range could be a reason for concern. Field, (2009) [19] suggests that values <1 or > 3 are a certain cause for concern.

3.2 Descriptive analysis

Majority of the small scale dairy farmers’ milk output(79%) was sold to the market than for home consumption (16%) and milk given out including to calves (6%) (Figure 1). This is a clear indication that majority of the small scale dairy farmers produce milk for commercial purposes than for other uses and thus indicating a good step towards dairy commercialization.

Despite the fact of Uasin Gishu having the highest number of dairy cows and among the leading counties in milk production in the country, availability of ready market has enabled farmers to sell most of their milk. After the dairy industry was liberalized in 1992, major shifts were created in milk marketing leading to the emergence of new processors, middle men or *brokers* and “milk hawkers”.

Figure 1: Utilization of milk output by small scale farmers in Uasin Gishu



3.3 Determinants of Milk Production

The adjusted R^2 was 0.403 meaning that the variables in the model collectively explained 40.3% of the variance observed in milk production in the study area. The factors influencing milk produced and marketable output in the County arepresented in Table 1 and Table 2 respectively. Study results revealed that price per liter of milk, total farm size, land size under dairy cattle, training on good husbandry practices, access to Artificial Insemination services, and group membership influences milk production in Uasin Gishu. Total farm size influences milk production with an elasticity of 0.309. This implies an elastic response to milk production, meaning that a unit increase in the total farm size increases milk production by 30.9%. Similarly, allocating more land to dairy increases milk output with an elasticity of 0.282, implying that a unit increase in the size of land under dairy increased milk production by 28.2%.

There was a significant and negative relationship between the price of milk and the total amount of milk produced (Table 1). This implies that famers will face lower prices with increased production. Majority of the farmers in the study area depend entirely on dairy and crop production for their living and hence income received from dairy has multiple uses and cannot be reinvested back to the dairy farm to increase milk production. This is in line with Olwande and Mathenge (2010) [20] who found out that milk price did not significantly influenced the quantity of milk produced.

Group membership had a significant effect on milk production ($P < 0.05$) hence implying that organizing farmers into dairy groups has a high affinity of increasing their outputs. Agwu et al, 2012 [21] argues that besides collective acquisition of resources and marketing, group membership increases knowledge sharing and learning experience among members. The results also indicate that there is a positive influence of training on dairy husbandry ($P < 0.05$) and access to AI services ($P < 0.05$) on milk production. This means that access to and availability of training and AI services increases the chances of enhancing milk production. Similar results were obtained by Wanjala, simon P. Omondi and Njehia, (2014) [22]. Musalia et al, 2010 [23] also reported similar results.

Since sex of household head and the duration of keeping dairy cattle did not significantly influence milk production it is a clear indication that anyone can do dairy farming i.e. both male and female and anyone can start at any time and be able to produce.

3.4 Factors Influencing Milk Output Supplied to Market

Table 2 presents the likelihood estimates of factors that determine the quantity of milk supplied to the market by small-scale dairy farmers. Variables significantly influencing the quantity of milk sold to the market were amount of milk produced and amount of milk consumed at home.

The amount of milk produced and amount of consumed at home significantly influenced the quantity supplied ($P < 0.01$). This means that the more milk is produced the more is supplied. This is in line with the normal supply curve. The same applies for the quantity consumed at home such that if more milk is consumed, given fixed output, less will be available for supply to the market. The value of adjusted R^2 (0.878) is high implying that the variation in milk supplied to the market is explained by the variables used. Similar results were reported by Birachi et al, 2010 [24] in Burundi.

Table 1: Determinants of Quantity of Milk Produced by Smallholder Dairy Farmers

Variable	Unit	Coefficient	Std. Error	t	Significance
(Constant)		3.642	1.034	3.522	0.001
Price per liter of milk	Ksh	-0.317	0.289	-1.098	0.004**
Total farm size	Acres	0.309	0.133	2.320	0.022*
Total area under dairy	Acres	0.282	0.135	2.084	0.040*
Sex of Household head	Dummy	0.069	0.121	0.571	0.569
Duration of keeping dairy cattle	Years	-0.012	0.009	-1.383	0.170
Trained on Dairy Husbandry	Dummy	0.031	0.110	-0.281	0.019*
Access to AI services	Dummy	0.010	0.104	-0.094	0.025*
Group Membership	Dummy	0.282	0.127	-2.221	0.029*

Dependent Variable = Total amount of milk produced, DW = 1.377, VIF = 2.057, Adjusted R^2 = 0.403, Sex of household head (0 = male, 1 = female), Training on dairy husbandry (0 = No, 1 = Yes), Access to AI (0 = No, 1 = Yes), Group membership (0 = No, 1 = Yes), **Significant at 1%, *Significant at 5%

Table 2: Factors Influencing Milk Output Supplied to the Market

Variable	**Unit**	**Coefficient**	**Std. Error**	**t**	**significance**
(Constant)		-0.698	0.208	-3.352	0.001
Total household size	Number	0.002	0.013	0.185	0.853
Total milk produced	Litres	1.324	0.053	24.918	0.000**
Average price of milk	Ksh	0.002	0.004	0.467	0.641
Milk consumed at home	Litres	-0.504	0.072	-6.978	0.000**

Dependent Variable = Total quantity of milk sold, DW = 1.126, VIF = 1.467 = 1Adjusted R^2 = 0.878, **Significant at 1%

IV.CONCLUSIONS AND POLICY RECOMMENDATIONS

The results of this study indicate that farmers are doing dairy farming for commercial purpose which is a clear step towards improving productivity and marketing. The government should therefore invest more in the sector to realize this objective. Given that group membership contributes positively to output farmers should be encouraged to join such groups including formation of cooperatives so that they can gain from coming together. Group supportive services should also be developed. Cooperatives also provide a good avenue for farmers to be trained on good husbandry and get services which they could not get if they worked in isolation including provision of AI services at affordable rates. Price stabilization should be at the core given that price is an important determinant of supply. Farmers should also endeavor to allocate more land and resources to the dairy enterprise given the positive correlation between acreage allocated and output of milk.

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