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Full Length Research Paper

Economics evaluation of relative profitability in small hold dairy farms in western Kenya

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The development and implementation of farm policies requires the general understanding of the farmers' response to the availed technology. Where farmers have similar resource endowment, generalization of policies would help improve their production levels. The farmers profit levels were used in comparing their relative efficiency in dairy farming in western province Kenya where a bilateral donor agency had come up with strategies to improve dairy farming and increase farm incomes. Using field data obtained from farmers who were beneficiary of the donor-aided project and the general dairy farmer, normalized profit function was used to generate the parameters that were used in the evaluation of the farmers' efficiency status. The results showed that although there are constraints in the production of milk, there exists an equal economic efficiency amongst farmers in the study districts. This would imply that policies can be generalized for the entire province but the existence of unique production constraints that are specific to each district would hinder this equality can be attributed to the utilization of similar technological packages provided by the donor agency.

Key words: Efficiency, profits, dairy, smallhold, district, Kenya.

INTRODUCTION

Agriculture contributes 25% of the total GDP and employs 75% of the total labour force in Kenya. With about 80% of the population deriving its livelihood directly from it (MOALD and M, 1998), the decline in this sector would lead to lack of employment and low incomes. This would increase poverty that is already at high levels among the rural population (Otieno, 2003). To alleviate poverty and enhance economic growth, higher preference should be given to this agricultural sector (ROK, 2000). Introduction of improved dairy technology in western province Kenya was meant to improve the milk output level as well as to alleviate the increasing poverty level. Approximately 66% of people in this region who are largely dependant on agriculture live below the poverty line of 1 US$ per day. Past studies have suggested that dairy farming can play an important role in improving and stabilizing income (MOALD and M, 1998). This is because the crop produce are mainly for consumption amongst majority small hold farmers', produce from dairy farming is mainly for sale (Brumby, 1991). The returns from dairy farming can then be invested in arable farming where yields are low. Improved dairy technology was used as an instrument for increasing dairy output among smallhold resource poor farmers who were to get higher returns and thus high profit levels. The profit level was to be the incentive for increased adoption of the technology.

This sector contributes 10 and 30% of the total national GDP and the total farm gate value of agricultural commodities (Omore et al., 1999). However the output from the dairy animals in this relatively high potential region was low. The region produced only about 108 million l of milk in 1998 - 1999 periods and had a requirement of 2.38 million l. This gave a deficit of 175 million l. looking at the production within the region, with the exception of Lugari district, all the other districts did not produce surplus milk.

The diverse agro ecological environment in the province is mainly caused by a difference in altitude. This affects the production levels of farmers which apparently are different despite the support from Kenya Finland livestock development programme (KF-LDP), a bilateral donor agency. The existence of different economic efficiencies among groups of farmers may be attributed to variation in milk output levels as well as the level of input used and price or allocate efficiently (Otieno, 2003).

A farmer is said to be technically more efficient than another one if he/she consistently produces more output

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given identical inputs. A farmer will equally be price efficient if the value of the marginal product is equated to its actual price. Any departure from this equality implies pricing inefficiency. Thus the natural measure of relative efficiency is the relative level of the actual profits (Lau, 1978).

The profit function was thus used in comparing the farmer efficiency level. A farmer is considered more price efficient if given the same prices of inputs and outputs and the same degree of TE he/she is more profitable than the other firms. Technically more efficient firm, which is also price efficient, will always be more profitable than another farmer, which is only price efficient (Lau, 1978). Thus technical efficiency does not imply relative role efficiency and vice versa.

SURVEY

The study area chosen for this analysis is a physiographically heterogeneous. It comprises of Busia, Lugari and Vihiga. The area lies between 1,130 m above sea level and 2,200 m above sea level. The area lies between Trans Nzoia, Bungoma, Uasin Gishu, Nandi, Siaya and Kisumu districts and Uganda. The major crops in this area are maize, beans, millet, sugarcane, sweet potato and millet. Most crops are grown for consumption or for sale. Livestock primarily provide a store of wealth against immediate need for cash of the individual farm firms. The survey was carried out between April and July the year 2000 in the selected districts and involved sample households visited once.

The data needed to develop the technical coefficients of the farmers total wealth values for the study was collected by and surveying the general dairy farmers who were beneficiary of the dairy development project as well as the general dairy farmer collected. A schedule used in defining the production pattern of the farmers was developed and pretested in Vihiga district. The information collected included the quantities and costs of all variable inputs, the dairy cattle production levels, herd size and farmer's characteristics. Separate summary forms were developed to record all capital items.

Technical coefficients of the model were determined for a representative farming unit based on a sample frame of 97 farmers' selected using a combination of multistage, cluster and random sampling technique. The sample was drawn from a sample frame of dairy farmers listed as potential and beneficiaries dairy farmers in the study area. The dairy farm budgets allowed the determination of the net returns. The values for land, capital and labour were determined using the survey data and local prices. For human labour, the value was determined by estimating the total hours of available labour, including correction factors for sex and age valuing each hour at the average wage rate in the study area. Annual values of farm capital were formulated and the user cost was estimated using the commercial bank interest rate that was prevailing at the time of the study. The annual net returns of the dairy production activity were subsequently worked out.

METHODOLOGY

The existence of different economic efficiency among groups of farms may be attributed to variation in milk output level at the same input level and price or allocative efficiency (A.E).

The profit function does not consider difference in technical efficiency (T.E) and pricing efficiency (P.E) that may exist between farms. The approach is that given comparable endowment, identical technology and normalized input prices, the profits of 2 firms are identical if they maximize profits. If one firm is more T.E. than the other, the profits will be different even if they have the same resource endowment and fixed inputs.

The model used in the evaluation of relative efficiency is derived from the works of Odhiambo (1983), Kilungo (1999) Yotopolous and Lau (1973) Lau et al (1979) and Arnade and Trueblood (2002). Using Cobb-Douglas function, with m variable inputs and n fixed inputs as used in Otieno (2003),

$$Y = F(x_i,.....x_m; z_1,.....z_n) \quad \text{.....1}$$

For I = 1,-----, 4
J = 1,-----, m

X_1 Land area allocated to livestock.
X_2 Livestock innovation.
X_3 Capital investment in dairying.
X_4 Labour use in dairying.
Z Is the fixed input.

This can be expressed as

$$Y = F(X,Z) \text{ in general .....2}$$

X and Z are vectors of variable inputs and fixed inputs respectively. Explicitly the short run production the output can be expressed as a function of n variable inputs as:

$$Y == e^{A}\prod_{i=1}^{n} x_i^{bi} e^{\varepsilon} \quad \text{.....3}$$

A = The relative efficiency measure.
X_i = Is the i^{th} is the variable input.
e = Is the error term.
b_i = Elasticity of the i^{th} input relative to output.

Relative efficiency and pricing efficiency can be obtained for 2 or more firms using the normalized profit function Adesina and Djato (1997), Odhiambo (1983) and Lau et al. (1979). With comparable endowment identical technology and normalized input prices, the actual normalized profits between firms should be identical if they have maximized profits. If one firm is more prices efficient than the other with the normalized input prices and normalized profit fixed inputs, then their actual normalized profit functions will be different.

The short run profit defined as revenue less variable costs is given by:

$$P = pF(X,Z) - \sum_{i=1}^{M} q_i^{*} X_i$$

$$= p\left[F(X,Z) - \sum_{i=1}^{m} q_i X_i \right] \quad \text{.....4}$$

$$= p\left[F(X,Z) - q^{i} X\right]$$

p is the nominal (money) price of output,

q_i^* = nominal price of input i

$q_i = q_i^*$ /p, normalized price of input I

and X, Z and q are the vectors of $/ x_i's, Z_j's$ and $q_i's$, respectively.

Substituting equation 3 into equation 4 the profit function becomes

$$\pi = p[Y - \sum_{i=1}^{M} q_i X_i]$$

$$= p\left[(e^A \prod_{i=1}^{n} x_i^{bi} e^{\varepsilon}) - \sum_{i=1}^{m} q_i X_i \right] \quad \text{.....5}$$

To be able to compare the 3 different dairy farming regions that made the study area, two dummies D_1 and D_2 are introduced in equation 3. The dummies took the values (1,0) for efficiency measure of Lugari relative to Busia and (0,1)) for efficiency measure of Vihiga relative to Busia and thus it becomes:

$$Y = e^A \prod_{i=1}^{n} x_i^{bi} e^{D_1} e^{D_2} e^{\varepsilon} \quad \text{.....6}$$

Equation 5 can thus be modified and it becomes

$$\pi = P[\ e^A \prod_{i=1}^{n} x_i^{bi} e^{D_1} e^{D_2} e^{\varepsilon}\ ] - \sum_{I=1}^{M} q_i x_i \quad \text{.....7}$$

Dividing all the parameters by the output price p gives the normalized profit function.

$$\pi^* = e^A \prod_{i=1}^{n} x_i^{bi} e^{D_1} e^{D_2} e^{\varepsilon} - \sum_{I=1}^{M} q_i^* x_i \quad \text{.....8}$$

It is hypothesized that farms in western province are identical up to a neutral displacement parameter. This means that the coefficient corresponding to natural logarithm of each of the inputs is identical in all farms.

A problem of model specification arises since normalized prices are used. Assuming that farmers maximize expected profits, this normalized restricted profit function with conditional factors included as fixed inputs, is used to show the farmers behaviour. By reorganizing the terms and taking natural logarithms of the equations of the 2 farming regions differentiated as low and high altitude and the 2 farming regions in the high altitude, the final equation used becomes

$$\ln\pi = A + b_1 \ln Con + b_2 \ln land + b_3 \ln cap + b_4 \ln labour + D_1 + D_2 + \varepsilon \quad \text{.....9}$$

Π = Profit.
A = Relative efficiency measure.
Ln = Natural logarithim.
Con = Cconcentrate used.
Land = Proportion of land used by the farmer in dairying.
Cap = User cost of capital.
Labour = Man days.
b_i = Parameter estimate.
D_1 = Efficiency dummy of Lugari relative to Busia
D_2 = Efficiency dummy of Vihiga relative to Busia
ε = Error term

With this form the least square estimation can be used. However for this research the OLS is used and the hypothesis being tested is:

H_o: $\beta = 0$ and $H_A = \beta_1 \neq 0$

A comparison of the relative technical efficiency is obtained by examining the coefficient of the group dummy variable. The test is evaluated using t test. That each resource identified significantly influence farm profits per farm per year was tested. This was done by testing for statistical significance of each β_i coefficient.

Hypothesis tested:

H_o: $\beta = 0$

$H_A = \beta_1 \neq 0$

t - statistics is then used to determine the significance of the variable. Given the values of t null hypothesis is not rejected or rejected depending on whether the calculated t > greater than or less than t - critical respectively. If H_o: was not rejected, then meant the factor under consideration did not influence enterprise profit. Rejection of H_o: indicates that the input influences enterprise farm profit. Equal economic efficiency was tested using the following hypothesis

H_O: $\alpha_I = 0$
H_1: $\alpha_I \neq 0$

The significance level is determined by t-test on the coefficients of the dummy for the group difference. The test is thus whether the dummy is zero or not. For the profit function interpretation was done as follows:

β_o Intercept the mean profit of all the farms in Busia.

$\beta_0+\alpha_1$ mean profit difference between the farms in Lugari relative to Busia.

$\beta_0+\alpha_2$ mean profit difference between the farms in Vihiga relative to Busia.

$\alpha_2 - \alpha_1$ mean profit difference between the farms in Vihiga relative to Lugari.

When $\beta I = \alpha_1 = \alpha_2 = 0$ it is implied that there is no difference between the mean profits of the farms.

When testing for the existence of economic efficiency, then one needs to look at the significance of α_1, α_2 and $\alpha_2 - \alpha_1$. If they are zeros, then there is no significant difference in the efficiency status between the districts and equal economic efficiency exists. However, in ranking the districts, the profit level of the 3 districts per animal was used. In comparing Vihiga and Lugari, the t-statistic was derived from the coefficients of the 2 dummies and their variances and covariance.

RESULTS AND DISCUSSION

The correlation matrix shows that there is low multicollinearity in the data set and as such it was used in regression analysis. However, before carrying out the regression analysis, Chow test was carried out to establish whether the coefficient of the parameters were the same

across the study area or not. The t-test for F test is expressed as:

$$F^* = \frac{(ESS_{UR} - ESS_R)/q}{(ESS_R)(SS - 3*q)} \quad \text{.....10}$$

F* Calculated F-statistics,
SS = Sample Size,
q = Number of restrictions,
ESSR = Error Sum of Square Restricted,
ESS_{UR} = Error Sum of Square Unrestricted.

This helped in deciding whether the data could be pooled or not. The results of Chow test however showed that the data could be pooled and that the coefficients of the parameters do not change a lot in the study area. This is because inclusion of dummy variables enables the parameters to change. The results of the Chow test showed that there is no significant difference between the parameters of the restricted and the unrestricted function and the regression results for the 2 functions are presented in Table 1.

R^2 value shows that the concentrates, land, capital and labour explained 56% of the variation in profit levels in the study area. The low R^2 value was due to the use of cross sectional data and lack of common underlying trend across the individual entities. The signs of all the explanatory variables are positive as expected. With the exception of labour and the efficiency parameters, all the other variables showed no significant effect on milk profits.

The results show that a 1% increase in concentrates would lead to a 0.326% increase in profit levels. The increment is significant. Studies by Otieno (2003) showed that the use of concentrate feed in the production of milk accounted for 45% of the total variable cost in dairy farming. The input was being used by 51% of the farmers and this reflected a high cost involved in the use of this input. With AI services costing KSh 800 per service, only 19.2% of the farmers in the study area were using it. Most farmers preferred the use of cheaper local bulls to serve their bull at a cost of KSh 100.The use of Kenya Finland livestock development programme (KFLDP) bull scheme was also considered expensive as its cost was KSh 200.

Capital is the single most expensive item that dairy farmers have to invest in. The study showed that a 1% increase in capital investment would lead to a 0.453% increase in milk profits. This increase was significant. The ratio of the capital investment in dairy cattle to crop enterprises in western Kenya was 9:1 (Otieno, 2003). The high investment ratio between the two was due to the high cost of the dairy inputs. A dairy cow was costing about KSh 25,000. This figure was quite high for the resource poor dairy farmers.

To establish whether there is a significant between the regions, t-test was used. In comparing Vihiga and Lugari, the standard errors were obtained from the values of the variance covariance matrix for the two dummies in Table 2.

In comparing the responsiveness of profit to the change in relative efficiency between Busia and Lugari, a 1% increase in efficiency will lead to a 0.336% more increase in Lugari relative to Busia. Comparing Vihiga relative to Busia, a 1% increase in efficiency will lead to a 0.107% more increase in Vihiga relative to Busia. Finally, in comparing Vihiga relative to Lugari a 1% increase in relative efficiency between Vihiga and Lugari, will lead to a 0.229% decline in profit in relative Lugari to Vihiga. The positive sign shows that the farms on the higher altitude, that are larger, are more efficient in input use compared to the farms in the low altitude areas. There is need to allocate more land to dairy activity in Busia and Vihiga. The positive sign for the land parameter supports this. From Table 1 it can be concluded that there is no significant difference in relative efficiency among the farms in the three regions being compared.

As such the hypothesis put forward in this study was rejected. Kilungo (1999) also found equal economic efficiency small holder dairy in Kiambu. The gross margin analysis would give the impression that the farmers in Busia get higher profits than those are Lugari. The gross margin analysis figures do not take into account the relationship between the levels of input use and the output levels. As such the results of the regression analysis which shows the responsiveness of the output to the input levels are more reliable in making decision concerning profit levels. The analysis of the restricted normalized profit function shows that the highest profit margins are realized in Lugari, followed by Vihiga and Busia has the least. These farmers relative to those in Lugari use low levels of input. Statistical evidence showed that the efficiency level in Vihiga, Busia and Lugari were not significantly different from each other.

The farmer's in Vihiga, with smaller land sizes and on lower altitude area relative to Lugari farmers get higher profit margins per animal. Dairying in the smaller farms in Vihiga is also more profitable than in larger farms in Busia. This is a discrepancy from the earlier notion that with high altitude, the profit levels are higher. Farmers in Vihiga can attribute this result to high levels of concentrate use. This factor has a significant contribution to the profitability of dairy farming. Using profit margin, as an index for efficiency, the most efficient region is Lugari, then Vihiga and Busia is the least efficient area in terms of input use in dairy production. For the entire study area, the sum for $\beta_0 + \alpha_i$ is positive implying that dairying is a profitable enterprise and that increase in relative efficiency will lead to higher profit levels.

Conclusion and Recommendation

The production frontiers involved are defined by the model and within the sample values. This implies that there may be techniques of production, not being

Table 1. Regression results for the normalized profit function.

	Restricted model			Unrestricted model		
	Coefficients ,β_I	Standard error	t-values	Coefficients ,β_I	Standard error	t-values
Intercept	2.633	1.458	1.806**	2.66	1.532	1.8**
Ln X_1	0.326	0.139	2.340*	0.29	0.155	1.872**
Ln X_2.	0.453	0.165	2.742*	0.449	0.176	2.557*
Ln X_3	0.376	0.139	2.704*	0.406	0.150	2.705*
Ln X_4	0.147	0.121	1.216	0.137	0.163	0.841
D_1				0.336	0.689	0.487
D_2				0.107	0.464	0.23
R	0.746			0.751		
R^2	0.556			0.563		
Adj R	0.495			0.466		
F-statistics	9.082 [6.33]			5.81[6.33]		

** Significant at 10% *significant at 5%.
Source author's data.
X_1 Concentrate, X_2 Fixed capital, X_3 Land β_4, X4 Labour, D_1 and D_2 are Relative efficiency measures.

Table 2. Variance covariance matrix of the variables used in the restricted profit function.

	Con.	Fixed Cap	Land area	Labour	D1	D2
Con.	0.024	-0.008	-0.008	-0.001	-0.014	-0.020
Fixed Cap		0.031	0.000	-0.006	0.019	-0.021
Land Area			0.022	0.000	0.019	0.011
Labour				0.027	-0.056	0.043
D_1					0.475	-0.125
D_2						0.215

Source: Authors data (2000).

practiced by any of the farmers in the sample that yield much higher output for the same kinds of inputs. Secondly, the estimated profits and yields pertain only to the districts under consideration. The second aspect arises out of the first and both indicate the need to take caution in attempting cross regional comparison. For example, a farmer in Busia might be technically more efficient in relation to his frontier than a farmer in Lugari whose production level could be considerably greater.

However, the present analysis was based on the belief that under adequate hypothesis testing, the data could be pooled despite different production structures. The results of the restricted normalized profit function suggested that there was no difference in economic efficiency. However, there were constraints to both milk output and profit levels that the dairy farmers in the study area meet. The constraints could be resulting from inappropriate input price policy, inadequate access to credit and technical know-how, and/or inadequate infrastructure especially with regard to the level of development of the input market.

The existing potential to increase profit levels in the dairy industry reveals a policy quandary. Most small holder dairy farmers face severe resource constraint. These are lack of funds to buy concentrates, AI services, veterinary services and improved dairy stock and the available land does not produce sufficient fodder for the dairy animals throughout the year. These services can be cheaply availed to the farmers through cooperative societies. Therefore strengthening the cooperative societies would help a lot in improving the dairying in the study area.

Encouraging private entrepreneurs to enter the distribution and marketing of these inputs will also promote dairy development in the study area. However, the continued support of dairy farming by the Kenya Finland livestock development programme (KFLDP) should not be withdrawn in haste before the private investors are fully prepared to take over the responsibilities of supporting the farmers. This is the only way commercial dairying can be encouraged to develop in this region and prevent the escalation of increasing poverty among this group of farmers.

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