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Full Length Research Paper

Rural poverty and input use efficiency in smallholder dairy farms in western Kenya

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Increasing agricultural productivity depends on the adoption of modern technology that involves the use of modern improved technical embodied inputs. However, farmers have different production decisions and ability to source and use the available inputs. In a study among smallholder dairy farmers in Western Kenya to establish their input use levels using profit maximizing method and marginality principles in making decision, the levels of use of land, capital, concentrate and labor were analyzed. The study found that land, capital, concentrate were underutilized while labor was excessively used. It was concluded that the large size of unskilled labor force was the cause of high poverty among the rural population. This is because farmers prefer using cheap unskilled labor that is not highly productive leading to low output from the dairy farming. The other three expensive factors are underutilized. It was thus recommended that poverty can be reduced through improvement of labor skills through training and farmer education on use of modern production technology packages would encourage their use and lead to increased agricultural production. Based on Say's law the demand for skilled labor would lead to a decline of unskilled labor force in the rural areas due to increasing better wage rates and thus a decline in the levels of poverty.

Key words: efficiency, inputs, smallholder, dairy, Kenya.

INTRODUCTION

Agriculture contributes 25% of the total GDP and employs 75% of the total labour force in Kenya. With 80% of the Kenyan population deriving its livelihood directly from this sector, its decline would reduce their employment levels. This would lead to low incomes and increased poverty amongst the rural population (Otieno, 2003, MOA, 1998). To alleviate poverty, modern dairy production technology was introduced in Western Kenya. This sector contributes 10% and 30% of the total national GDP and the total farm gate value of agricultural commodities (Omore *et al,* 1999). The dairy development program aimed to increase and stabilize incomes through improvement in milk production.

This is because unlike crop produce which are used for home consumption amongst majority small hold farmers, dairy produce is mainly for sale and the returns are invested in arable farming where yields are low(Otieno, 2003, Woomer *et al*, 1997, Brumby, 1991). However the output from the dairy animals in this relatively high potential region was found to be low. The region produced about 108 million litres of milk in 1998-1999 periods and had a requirement of 2.38 million litres giving a deficit of 175 million litres. However, of all the 8 Districts in Western Kenya, only Lugari produced surplus milk. The production differences was attributed to existing differences in production efficiencies as well as the level of input used and price or allocate efficiently (Otieno, 2003). The study therefore set to evaluate farmers' production decisions of dairy farmers in using four selected inputs, land, labour, capital and an aggregate of concentrate feed, Veterinary services, breeding services and salt lick jointly referred to as concentrate.

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METHODOLOGY

The study was carried out in a physiographically heterogeneous area comprising of Busia, Lugari and Vihiga. The area lies between 1130 metres above sea level and 2200 metres above sea level and lies between Trans Nzoia, Bungoma, Uasin Gishu, Nandi, Siaya and Kisumu Districts, and Uganda. Major crops in the area are maize, beans, millet, sugarcane, sweet potato and millet. Most crops are grown for consumption and 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 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. The 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 18% commercial bank interest rate. The annual net returns of the dairy production activity were subsequently worked out.

Using a Cobb-Dauglas model, a Production function equation 1, was used to estimate the parameters used in the evaluation of allocative efficiency in a regression.

$Y=f(X_i,), i=1,2,\ldots\ldots\ldots\ldots,m$ ----------1

Where Y level of output and X_i i^{th} input.

The decision criterion was dependent on the marginality principle derived from the profit maximization function. Since firms strive to maximize profit, for any single product with a production function **$Y=f(x_1\text{----}x_n)$,** and a set of input prices w where **$W=(w_a\text{----}w_n)>0$,** with output prices p where **$p>0$,** The basic problem then becomes one of choosing a production plan within the available technology so as to maximize profit.

$$Max\,\pi = R(x_i - - - x_n, P) - C(w_1 - - - w_n Y) = Pf(x) - \sum_{i=1}^{n} w_i x_i$$

$$s.t.$$

$$x_i \geq 0$$

$$p, w > 0$$

.....2

The first order condition after applying Kuhn-Tucker theorem becomes

$$\frac{\partial \pi}{\partial x_i} = \frac{\partial RP(x^*)}{\partial x_i} - \frac{\partial C(w,y)}{\partial x_i} \leq 0 \quad \text{----------3}$$

The MPP indicates the expected increase in output from an additional unit of the relevant resource, with the level of other inputs remaining constant. The MPP of resource X_I used in dairy production can be written as;

$$MPP_{Xi} = \frac{\partial Y_j}{\partial x_i} = b_i \frac{Y}{x_i} \quad \text{.....4}$$

Y is the estimated dairy output, x_i is the i_{th} resource used and b_i is the production elasticity associated with factor I, while all the other factors are held constant. MPP, evaluated at their geometric means (Otieno, 2003) were used to derive the marginal value product of the resources (MVP) Table 2. At equilibrium, MVP equals MC equation 5

$MC_{xi}=MVP_{xi}$ 5

The problem arises due to aggregation of some inputs. Their proportionate shares of the total variable input costs were thus used as their prices. Equation 11 was thus used to derive their MVP Beattie and Taylor (1985).

$$MVP_{x_i} = \frac{biY}{x_i}, Py = MVP_{xi} \quad \text{.....6}$$

RESULTS AND DISCUSSION

Multicollinearity was tested and eliminated by comparing adj.R and the coefficient of correlation and the four variables were used in regression (Otieno, 2003). Table 1 shows the results of the regression analysis of the production function.

The R^2 values and the significant F-statistic suggested that the selected variables adequately explained the output considering that cross sectional data was used. A positive sign for the coefficient of the factor indicated that its increased use leads to an increase in output while the negative sign implied an output decline.

The analysis of the pooled data shows that increased use of concentrates, capital investment and increases in land rent leading to significant increases in dairy output while labour use had no effect. The coefficients of regression of the pooled data were the used to estimate

Table 1: Estimates of the stochastic frontier model for the dairy farmers in Western Province.

	BUSIA	VIHIGA	LUGARI	POOLED DATA
β_0	5.092 (1.493)***	2.389 (1.503)	0.932 (0.792)	1.74 (0.616)***
β_1	0.246 (0.078)***	0.347 (0.089)***	0.118 (0.214)	0.278 (0.061)***
β_2	0.021 (0.185)	0.459 (0.227)***	0.566 (0.201)***	0.437 (0.091)***
β_3	0.260 (0.092)***	-0.070 (0.072)	0.356 (0.114)***	0.213 (0.053)***
β_4	-0.055 (0.053)	0.075 (0.046)	0.035 (0.0709)	0.045 (0.35)
R^2	0.54	0.68	0.72	0.68
Adj R	0.46	0.63	0.69	0.64
Std Error	0.85	0.61	0.99	0.62
F-Statistics	7[4,26]	13[4,27]	21[4,35]	17[4,93]

***significant at 1%. Standard error in parenthesis. Source Author's data
β_0 Intercept, β_1 Concentrate, β_2 Fixed capital,β_3 Land and β_4 Labour

Table 2: Input use efficiency test at their geometric means.

Variable	Concentrate	Capital	Land	Labour
GM for milk	6.91	6.91	6.91	6.91
GM for inputs	8.51	10.80	0.325	8.00
MPP	0.226	.28	4.91	0.039
MVP	5.64	6.99	122.8	.97
P_x=MFC	2.56	6.52	7.50	3.91
MVP/MFC	2.20	2.13	52	0.241
Critical t	1.65	1.65	1.65	1.65
Calculated t	26	6.48	23.37	-2.6
Df	97	97	97	97
Test	Cal t> Crit t	Cal t> Crit t	Cal t> Crit t	Cal t□ Crit t
Decision	Significant	Significant	Significant	Significant
Interpretation	Inefficient	Inefficient	Inefficient	Inefficient

Source: Author's data 2003 GM= Geometric mean.

the MPP and MVP. Table 3 shows the results of input use efficiency at their geometric mean and producer price of milk at KShs. 25 per litre. The MPP of concentrate is 0.226 litres implying that an expenditure of KSh 1 on it increases the output by 0.226 kg and the MVP resulting from this increase would be Ksh 5.64. The MPP of capital, land and labour were 0.28litres, 4.91 litres and 0.039 litres of milk respectively.These would be associated with marginal value products of Ksh 6.99, Ksh 122.8 and Ksh 0.97.

The interpretation for this using concentrates is that a Ksh 1.00 increase in the use of one additional unit will result in an additional increase in product worth Ksh 5.64. The MVP for Concentrate, fixed capital, land rents and labour were significantly different from their MFC. The MVP for capital, concentrate and land was significantly higher than the corresponding marginal factor costs. It was thus concluded that these factors were being underutilized. Thus increased level of use of these factors earns the farmers more since the cost of their use is low. For labour, the MVP associated with increased use of the factor is much lower than the increased costs. This suggested that an increase in the level of the already overused factor would lead to further losses.

The study shows that concentrate would significantly increase milk output in Busia and Lugari. This input was analyzed as an aggregate of concentrate feed, salt lick, veterinary and breeding services. It accounted for 59% of the total cost and was used by 47% of the sampled farmers. While 51% of the farmers in Busia used it, 47% and 59% used it in Lugari and Vihiga respectively. Artificial insemination services (AI) was used by 19.2% of the sampled farmers with 13.3% of farmers in Busia using it, 26.6% in Lugari and 23.3% in Vihiga.

The high costs of AI services costing KSh 800.00 per service discouraged its use in favour of the cheaper local bull services that costed KSh 100 and improved bull service which costed KSh 200. It was recommended that animal feed, veterinary and Artificial Insemination services be availed at affordable prices to encourage their use. The existing milk output levels and the system of production requires that more land be allocated to dairying in Busia and Vihiga and a reduction of area in Lugari. More land can be availed by intensifying the

Table 3: Gross Margin Analysis at sample mean

District	Busia	Lugari	Vihiga	Pooled Region
Total Revenue	110,138.6	65,506	82,088.9	85,809.2
Total Variable Cost	11,299.7	13,752.0	15,626.5	13,535.1
Gross Margin	98839	52176	66,462.4	72,274.1
Total Fixed Cost	76,741.8	68,615.8	70,800.6	71,938.4
GM/Labor	4.3	2.5	15.7	8.3
GM/Variable Cost	8.75	3.79	4.25	5.34
Profit	85,025.4	39,825.3	53,718.3	59,325.2
Profit / cow/yr	13,938.59	6,986.90	16,786.97	12,107.18

Source: Author's Data 2003

Table 4: Labour profile among farmers (%) in the study area

Labour	Busia N=30	Lugari N=30	Vihiga N=36
Permanent	14	57	10
Casuals	87%	93%	100%
Family	29	7	70
Expenses (KSh)	900	400	600

Source: Author's data 2003.

Table 5: Distribution of dairy stock housing structure in the study area (%)

District	Busia	Lugari	Vihiga
Permanent	13	5	20
Semi permanent	5	0	10
No structures	12	25	7
Zero grazing units	42	17	54

Source: Author's data 2003.

production system while reduction can be achieved through increase in land rent or stocking rates for the dairy animals. Land rate were high in Vihiga, KSh 220,000/acre, KSh 60,000/acre in Busia and least in Lugari KSh 22,000/acre and this affected its allocation to dairy in the Province. The land can be used for growing fodder crops. The rural poor could only use land for enterprises that produced food to meet their domestic needs. Land increases would be meant for fodder production since many farms are under zero grazing. Alternatively, there will be need to develop fodder markets.

High dairy output in Vihiga required increased capital investment and allocation of more land. Capital investment was analysed as the the average costs were KSh 9,475 in Busia, KSh 11,991 in Lugari and KSh 21,308 in Vihiga. .annual average user cost of the dairy structures in the farm. Low levels of capital use could be attributed to high costs of investing in dairy farming where a mature dairy crossbred cow on average costed KSh 25,000. Labor resource had no significant effect on the level of dairy output. It was mainly permanent and casual worker and to a small extent by the family.

The sampled farms in the three Districts showed that they depended on casual labourers largely because it was cheap. Labour had an averge cost of KSh 900 in Busia, KSh 400 in Lugari and KSh 600 in Vihiga. The high cost in Busia was due to allocation of large parcels of land to dairying while scarce population to provide the required labour. Farmers in Lugari practiced extensive dairy production system reflected by the low number of zero grazing units Table 4 and 5.

CONCLUSION

The production frontiers involved are defined by the model and are within the sample values. This implies that

there may be techniques of production, not being practiced by any of the farmers in the sample, which yield much higher output for the same kinds of inputs. Second, the estimated profits and yields pertain only to the districts under consideration. The study therefore found that farmers underutilized concentrates/feeds, land, and capital while labor was excessively used.

The excessive use of labor resource implied low wages were being paid and this exacerbated poverty. Therefore to improve labor productivity and thus alleviate poverty amongst the rural poor, formulation of policies that offer job opportunities with higher opportunity cost within both agricultural and industrial sector. Improving labor skills through training would also decrease the supply for such labor to farms and facilitate its reallocation to other better paying sectors. The net effect is a reduction in the size of the rural labor force and thus a potential increase in wage rates and a contribution to poverty alleviation.

Efficient use of labor means the use of a small paid well labor force that has a better standard of living. Labor has a positive correlation with land size and negative correlation with technology and capital use. For farmers to be encouraged to use more concentrates, AI services and feed additives, focus should be on educating farmers on the need to use high quality dairy breeds, better animal feeding practices and use of on farm production of good quality feed. The expensive high quality dairy stock should be availed through affordable credit system that can be obtained through well organized sustainable farmer cooperative societies to which farmers can be affiliated through a minimal subscription fee. Addressing these issues would lead to increased agricultural productivity, decreased levels of rural poverty and increased contribution of dairy farming to the agricultural and national GDP.

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Appendix

Table 6: Beneficiary farmers and their affiliation to community organzation (%)

District	Busia	Lugari	Vihiga
Beneficiary farmers	52	31.1	29.7
Community membership	51.7	70.4	66.7

Source: Author's data 2003

Table 7: The proportion of farmers' using selected inputs by Districts (%)

	Busia	Lugari	Vihiga	Pooled data
Farmers using AI	13.3	26.6	23.3	19.2
Farmers using Salt Lick	70	80	48	61.5
Farmers using Veterinary services	75	90	76	78.2
Farmers using concentrates	51	47	59	51

Source; Author's data 2003