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Resource Use Efficiency among Smallholder Dairy Farmers in Western Kenya

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Abstract

This study was conducted to find out whether dairy farmers could increase their profits through intensification of input use. Data was collected from 150 farmers in three dairy production systems. Data collected included the resources used in milk production, yields obtained, prices of inputs and output and the problems faced by farmers in dairy production. Gross margin analysis was done and results indicated that the GMs for the three systems are not significantly different from each other. Quadratic and Cobb-Douglas functions were fitted using the inputs used in dairy production and marginal products equated to inverse price ratios. The results showed that the highest scope for increasing milk yield and profit exists in zero grazing where it is possible to increase milk yield by 94.4% through increased use of concentrates and farm by-products. For semi-zero and extensive grazing systems, farmers could increase milk yield by 57.5% to reach economic optimum by using more concentrates and forages. The important conclusion which can be drawn from this study is that there is unexploited potential in the three dairy production systems. The study recommends that farmers should be encouraged to use more

concentrates and by-products by addressing problems which lead to limited use of concentrates and by-products.

Key words: *Dairy production systems, intensification, profits.*

Introduction

Agriculture is the mainstay of Kenya's economy and accounts for 53 percent of the GDP directly and indirectly. One of the main strategies of achieving the role of agriculture in the economic development of the country is to increase productivity in the production of both crops and livestock. Intensive methods of livestock production have received little attention yet livestock continue to play an important role in development of most countries. With intensification some land can be released for other economic activities. However there are a number of constraints that farmers face in their efforts to adopt intensive systems of dairy production (Kenya, 1993). The study objectives were:

1. To analyze costs and returns associated with different dairy production systems and to determine the profitability of each system.
2. To find out whether there was scope for increasing yield and profit under each dairy production system.

Materials and Methods

The study area

This study was conducted in Rigoma and Borabu Divisions of Nyamira District, Nyanza Province. It lies between latitude 0030′ and 0045′S and longitude 340-45′ and 35′00E with two main topographical zones; the first zone covers areas whose altitude lies between 1500m and 1800m while the second covers all the areas lying above 1800m (Jaetzold1982) . It has a highland equatorial climate with high and reliable rainfall which is well distributed throughout the year. It has fertile soils which can be classified into three categories namely: Nitosols (75%), Vertisols (20%) and Peat (5%). The District was selected because although the pressure on land is quite high it has both extensive grazing and intensive systems.

Sampling design and data collection:

Three grazing dairy production systems were considered as defined by Chudleigh (1974).

Two cooperative societies from Borabu farmers union were randomly selected for study. From the registers kept by the societies 50 farmers were selected randomly. In Rigoma dairy farmers who practice the zero and semi-zero-grazing systems were identified. Fifty farmers were randomly selected for interview under each system. Field data was collected by use of a questionnaires designed to get information on factors determining milk output. Farmers were personally interviewed using a pre-designed and pre-tested questionnaire to get the required information. Each farmer was visited once during the study.

Methods of data analysis

Main methods of analysis used were Gross margin analysis and the production function analysis. There was a general assumption in all the system of grazing that milk yield Y is dependent on concentrates, by products, forages and labour. It was assumed that interaction was possible in use of by-products, concentrates, forages and labour. Other factors such as breed effect and herd size were held constant.

Gross margin analysis

Gross margin (GM) was calculated as outlined in Barry et al (1988) and Coy (1982).

GM = T.I – VC

Where:

GM = Gross margin

T.I = Total Income

VC = Variable Costs

The total income here refers to the value of the milk produced. The average price Kenya shilling (Ksh) per litre realized by farmers in the study area was multiplied by the milk produced by each cow to get the total income per cow. The variable costs included expenditures on farm forages, veterinary fees all expressed in Ksh per cow per year. After computing the gross margin for the three grazing systems one way analysis of variance was used to find out whether the gross margins were significantly different for the three categories of farmers.

The production function approach

A production function is a quantitative relationship between inputs and outputs (Heady and Dillon 1981). A production function defines the production possibilities available to the farmer. With such production function together with information on prices and opportunity costs, one can judge and also study the effect on production of alternative government policies influencing prices and a quality of resources available to the farmer.

A general production may be represented as

$Y=f(X_k) + e_i$……………………..(1)

Where

Y = the output of milk per cow (yield)

X_k = set of k inputs

e_i = error term

Such a model is chosen and values of its parameters (co-efficient) are estimated from the relevant data preferably by some maximum likelihood statistical procedure or by ordinary least squares (OLS) regression (Wonnacot and Wonnacot 1979). It is the modelling of these physical relationships that prove a major difficulty. The OLS regression method was adopted. To keep the estimation problem manageable some simplifying assumption are made in OLS estimation (Pindyck and Rubinfeld 1981).

The levels of inputs that maximize profit may be given by the combination at which the value of the additional produce obtained from a small increment of each input just balances the cost of the added input (Doll and Orazem 1984). In doing this considerations are given to the economic circumstances of the farmers and to the alternative demands on the limited resources other than for the production of milk.

Results and Discussions

Gross margin analysis

Gross margin was computed for each farm and the means for the three systems of grazing were compared to find out if they showed statistically different results. Gross margin was computed on per animal basis. All the milk produced was valued. Table 1 below gives the expenses considered and the mean gross margin for the three systems of grazing.

Table 1: GM analysis for three systems of grazing

Item	System of Grazing		
	Zero	Semi-zero	Extensive
Milk yield (kg/cow/yr)	2688.407	2418.92	2613.261
Milk value (ksh/cow/yr)	38406.58	34544.86	37333.047
Fodder (ksh/cow/yr)	3411.775	1529.101	440.158
Pasture (ksh/ cow/yr)	0	633.923	2508.00
Treatment (ksh/cow/yr)	279.803	226.667	456.504
Drugs (ksh/cow/yr)	498.153	249.238	466.73
A.I of bulls(ksh/cow/yr)	84.51	53.617	48.635
Purchased feeds (ksh/cow/yr)	1652.10	262.223	548.452
Housing (ksh/cow/yr)	383.860	0	0
Labour (ksh/cow/yr)	977.277	584.624	298.163
Gross margin (ksh/cow/yr)	28693.30	29323.82	31709.19

Source: Author's Survey, 2011

One way analysis of variance was done to find out whether gross margin was different for the three systems of grazing. The results showed that the gross margin realized is currently not significantly different for the three systems of grazing. This may be because farmers may not be using resources optimally in one or all of the three dairy production systems.

Regression analysis results

In order to find out whether farmers could increase gross margin further the data was subjected to production function analysis. The semi-zero and extensive grazing data were pooled since Chow test showed that they were not different with respect to regression parameters. The Quadratic and Cobb-Douglas models were estimated. The Quadratic model best fitted the data compared to the Cobb-Douglas. The evaluation was on the basis of R square and adjusted R square, F and t-statistic. The results of OLS estimation of the Quadratic model are given are given in table 2, and 3.

Table 2: Regression results for Zero grazing system (Quadratic Model)

Variable	B	SE B	t	Pro. level
Intercept	691.44	346.0	2.000	0.0519
Farm forage FT	0.1905	0.1130	1.691	0.1865
By-products (B)	0.0589	0.293	0.201	0.8418
Concentrates (CON)	18.29	2.370	7.71	0.0000
Labour (L)	0.12226	0.1710	0.715	0.4784
Square terms				
(FT^2)	-3049.0	755.0	- 4.03	0.0002
B^2	477.0	132.27	3.606	0.0008
CON^2	-0.2424	0.4129	0.587	0.3865
L^2	- 0.1856	0.212	-0.875	0.3865
Interaction Terms				
BCON	-6.66	1.4	-4.8	0.0000
FTCON	0.2713	0.3273	-0.829	0.4110
FTL	3.70	0.96	3.8	0.0008
BL	-0.2193	-0.1720	-1.275	0.2586
CONL	-0.1057	0.1389	-0.761	0.7494
FTB	-0.044	0.2788	-0.02	0.8751

$R^2 = 0.680$ Adj.$R^2 = 0.63$ F= 15.75 sig. F = 0.000 n=51

Source: Authors' computation, 2011

Table 3: Regression results for semi-zero and extensive grazing (Quadratic model)

Variable	B	SE B	t	Pro. level
Intercept	1223.15	165.39	7.40	0.0000
Farm forage FT	1512.04	372.37	4.06	0.0000
By-products (B)	0.053	0.077	0.730	0.4674
Concentrates(CON)	14.93	1.37	10.93	0.0000
Labour (L)	0.34	0.055	0.527	0.5995
Square terms				
(FT^2)	-3049.0	755.0	- 4.03	0.0002
B^2	477.0	132.27	3.606	0.0008
CON^2	-0.2424	0.4129	0.587	0.3865
L^2	- 0.1856	0.212	-0.875	0.3865
Interaction Terms				
FTB	-0.1238	-0.1134	-1.083	0.2818
BCON	0.0576	0.0714	-679	0.4986
FTCON	0.20116	0.11429	1.091	0.2780
FTL	-0.082	-0.082	-0.781	0.4371
BL	-0.0408	-0.0635	-0.604	0.5476
CONL	-0.4224	-0.0569	-0.540	0.5902

R^2 = 0.640 Adj.R^2 = 0.624 F= 40.52 Sign.F = 0.000 n=96

Source: Authors' computation, 2011

(Three questionnaires for the semi-zero and one for extensive grazing were lost thus reducing n from 100 to 96)

In the zero grazing function attention needs to be drawn to the variable by-products, farm forage and labour. The t-statistic shows that the coefficients are not significant at 25%. This means that no significant role is being played by by-products, labour and farm forage in explaining the variability in milk yield among the zero grazing farmers in the sample. Therefore these variables were left out in deriving optimal levels of inputs use. Similarly the squared terms of concentrates (CON^2), and labour (L^2), and the interaction of farm forages with by-products (FTB), farm forages with concentrates (FTCON), concentrates with labour (CONL), By-products and labour (BL) were not statistically significant in influencing milk yield. Their coefficients were not significant at 5% level. They were also not used in deriving optimal levels of input use.

In the semi-zero and extensive grazing function, the variables by-products, labour, the squared terms of by-products (B^2) and labour (L^2), and all the interaction terms have coefficients whose t-statistics are not significant role is being played by these variables. The major determinants of milk yield were forages and concentrates. The squared terms of forages (Ft^2), concentrates (CON^2) had negative coefficients and this describes the biological response phenomenon correctly. This is because the law of diminishing returns holds in milk response to feed intake by cows.

Economic optimization

Economic optima give the best operating conditions. The best operating conditions are obtained by setting the marginal productivities equal to their inverse price ratios. The optimal milk yield is obtained by substituting for this value in the model.

Table 4: comparison of farm average and economic optima in the three systems of grazing

Zero Grazing	Economic optimum	Farm average
Concentrates kg/cow/yr	384.8	174.394
By – products kg/cow/yr	1.04	0.36
Farm forage kg/cow/yr	0.2	0.23
Labour kg/cow/yr	954	977.3
Milk yield kg/cow/yr	5227	2688.407
Semi-zero and extensive		
concentrates (kg/cow/yr)	235.3	46.73
Farm forage (ha/cow/yr)	0.4	0.28
Milk yield (kg/cow/yr)	3964.8	2517.89

Source: Author's Calculation, 2011

From the results of the economic optimization presented in the table 4 it can be seen that semi-zero and extensive systems it is possible to increase milk yield by 57.5% (from 2517.89 kg/cow/year) to 3964.8 kg/cow/year). This could be achieved through increased use of concentrates which should be increased from 46.73% kg/cow/year to 235.3 kg per cow per year. Farmers could also increase farm forages 42.9% to reach the economic optimum for this input. The zero grazing farmers on the other hand could increase their milk yield by 94.4% (2538.6kg/cow/year above current levels) to reach the economic optimum by using more concentrates (an increase of 100% to reach economic optimum) and more by-products (an increase of 160% to reach economic optimum). Zero grazing farmers used labour and farm forage at levels close to economic optima for these inputs.

Policy implications

The findings from this study show that the problem in milk production seems to lie with the feeding management of the dairy cows. The main efforts to increase milk yield should be directed at encouraging farmers to use more concentrates. Maize stover was the common by-product used by farmers. This was used when dry and of poor quality. Farmers should be educated on better ways of using maize stover. Quality enhancing procedures like post harvest chemical treatment should be taught to farmers for better utilization of this resource. Kenya's Dairy Development Policy which aims at intensified production is supported by findings in the study.

Conclusion

This study aimed at finding whether there is scope for increasing profit under each dairy production system through intensive use of inputs. Use of regression analysis and economic optimization procedures indicated that semi-zero and extensive grazers could increase their milk yield by 57.6% to reach the economic optimum by using more concentrates, farm forages and capital. The highest scope for increasing milk yield exists within the zero grazing system where milk yield can be increased by 94.4% by increased use of by-products and concentrates. The major conclusion is that there is unexploited potential in dairy production in the three systems of grazing.

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