RESOURCE USE EFFICIENCY AMONG SMALLHOLDER DAIRY FARMERS IN WESTERN KENYA

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INTRODUCTION

- Agriculture is the mainstay of Kenya's economy and provides the basis for development of other sectors.
- The sector accounts for 53 percent of the gross domestic product 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.

- Policies to increase agricultural productivity in most countries of Africa have concentrated on crop production.
- Intensive methods of livestock production have received little attention
- Intensified production will require availability of dairy production credit to enable farmers to: cull low productivity dairy cattle, adopt Zero grazing, and improve pasture production.
- With intensification some land can be released for production of crops and other economic activities.

There are three dairy production systems practiced in the high potential areas of Kenya:

- **Grazing systems** are systems where on farms more than 50% of forage production consists of pasture land.
- **Semi-zero** grazing when fodder crops constitute between 50% and 80% of the available forage area
- **zero-grazing** when more than 80% of the total available forage area in planted with fodder crops.

The study objectives

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

METHODOLOGY

- This study was conducted in Nyamira County, Nyanza Province.
- The County lies between latitude 0030' and 0045's and longitude 340-45' and 35'00E.
- The County occupies approximately 861 square kilometers
- The County has been divided into two main topographical zones. The first zone covers all areas whose altitude lies between 1500m and 1800m above sea level. The second zone covers all the areas lying above 1800m.

- 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 County was selected because although the pressure on land is quite high it has both extensive grazing and intensive systems.
- It can therefore represent other areas where smallholder dairying is practiced.

SAMPLING

- Two cooperative societies from Borabu farmers union were selected for study.
- From the registers kept by the societies 50 farmers were selected using a random procedure for interview.
- In Rigoma with the dairy farmers who practice the zero and semi-zero-grazing systems were identified & two lists were prepared; one for zero-grazing, and another for semi-zero grazing system. Fifty farmers were randomly selected and interviewed under each system.
- Primary data was collected by use of a questionnaires designed to get information on factors determining milk output while secondary data was obtained from relevant reports journals and other publications.

DATA ANALYSIS

- Main methods of analysis used were Gross margin analysis and the production function analysis.
- There was a general assumption in all the systems of grazing that milk yield (Y) is dependent on concentrates, by products, forages and labor. It was assumed that interaction was possible in use of by-products, concentrates, forages (pasture fodder) and labor.
- Other factors were held constant e.g. included breed effect and herd size.

OPTIMAL LEVEL OF INPUT USE

To determine the optimal level of input use, we assume

$M = f(X_1, X_2, \ldots\ldots\ldots, X_n)$ is the milk response function where.

M= Milk output Kg/Cow/Year

$X_i \ldots\ldots\ldots X_n$ = input levels all expressed on per cow per year basis.

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.

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.

Profit will be maximized when:

$$\frac{\delta\pi}{\delta X_i} = 0$$

Where π is the profit function given by $\pi = P_m M - P_{xi} X_i$

Where P_m = milk price

M = milk produced

X_i = Factor Input

P_{xi} = Factor Cost

The function being unconstrained, the best operating conditions are obtained by setting marginal productivities equal to their inverse price ratio i.e.

$$\frac{\delta M}{\delta x_i} = \frac{P_{xi}}{P_m}$$

From which one can solve for the optimal level of inputs X_i.

RESULTS

GROSS MARGIN RESULTS

- Gross margin was computed for each farm and the means for the three systems of grazing were compared to find out if they were statistically different.
- Table 1 below gives the expenses considered and the mean gross margin for the three systems of grazing.
- 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.

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
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)	1652.1	262.223	548.452
Housing (ksh/cow/yr)	383.86	0	0
Labour (ksh/cow/yr)	977.277	584.624	298.163
Gross margin (ksh/cow/yr)	28693.3	29323.82	31709.19

REGRESSION RESULTS

- Two models were estimated for each set of data. These were the Quadratic and Cobb-Douglas models.
- The quadratic specification described 68.0 percent and 64.0 percent of the variation in milk yield for zero and semi-zero and extensive systems of grazing respectively. (see Table 2) and Table 3
- These measures are given by the R^2 statistic which indicates the goodness of fit of a model specification. The respective adjusted R^2 statistic was 63% and 62.4%.
- The F-statistics are respectively 15.75 and 40.52 both significant at 99% level of confidence.

Table 4 Regression Results for semi-zero and extensive grazing (Cobb-Douglas Model)

Variable	B	SE B	t	Pro. level
Constant	6.81	0.71057	9.5484	0
In Ft	0.0934	0.2264	0.412	0.6834
In B	-0.0701	0.1304	-0.538	0.5954
In CON	0.0658	0.1219	0.54	0.5938
In L	0.0958	0.139	0.689	0.4967

R^2 = 0.2904;

Adj-R^2 = 0.0843

F= 5986 Sign.F = .6670

Table 5: Regression Results for Zero grazing (Cobb-Douglas Model)

Variable	B	SE B	t	Pro. level
Constant	6.6902	1.768	3.784	0.0005
In Ft	0.0299	0.1243	0.241	0.811
In B	0.0547	0.1124	0.487	0.6292
In CON	0.2244	0.0674	3.328	0.0019
In L	0.0053	0.25	0.21	0.9831

$R^2 = 0.2339$

- In the zero grazing function attention needs to be drawn to the variable by-products, farm forage and labor. The t-statistic shows that the coefficients are not significant at 5%.
- Similarly the squared terms of concentrates (CON^2), and labor (L^2), and the interaction of farm forages with by-products (FTB), farm forages with concentrates (FTCON), concentrates with labor (CONL), By products and labor (BL) were not statistically significant in influencing milk yield. Their coefficients were not significant at 5% level.

- In the semi-zero and extensive grazing function, the variables by-products, labour, the squared terms of by-products (B2) and labour (L2), and all the interaction terms have coefficients whose t-statistics are not significant.
- The major determinants of milk yield were forages and concentrates. The squared terms of forages (Ft2), concentrates (CON2) 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.

Cobb- Douglas Model

- The specifications estimated for this study are given in tables 4 and Table 5. These specification explained 23.39% and 29.04% of the variation in milk yield for zero and semi-zero and extensive grazing systems respectively.

- The Cobb-Douglas specifications were not used to find out whether farmers used inputs optimally since the quadratic models were judged to be better on the basis of R square statistics, and the number of coefficients which were significant at 5% level.

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. Hence the zero grazing model given as:
- M= 691.44-6.7BCON + 18.3 CON + 3.7FT – 622.46FTL + 477B2 – 3049FT2…….(4.1)
- We set the marginal productivities equal to their inverse price ratios and find the optimal level of each input. The optimal milk yield is obtained by substituting for this value in the model. Similar procedure is used for semi-zero and extensive grazing model given as
- M= 1223.15 + 14.93CON -0.03 CON2 + 1512.04FT – 622.46FTL2 ……. (4.2)
- These results are summarized in Table 4 below

DISCUSSION

- 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 3968.16 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.
- Zero-grazing farmers on the other hand could 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% 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 labor and farm forage at levels close to economic optima for these inputs.

CONCLUSION

- This study aimed at finding whether there is scope for increasing profit under each dairy production system through intensive use of inputs.

- The major conclusion is that there is unexploited potential in dairy production in the above three systems of grazing.

- Semi-zero and extensive grazers could increase their milk yield by 57.6% to reach the economic optimum by using more concentrates and farm forages.
- 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.

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.
- Kenya’s Dairy Development Policy which aims at intensive dairy production systems is supported by findings in the study.