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A COMPARISON OF THE RELATIVE RETURNS TO DIFFERENT ENTERPRISES ON MIXED SMALLHOLDER CROP-DAIRY SYSTEMS IN CENTRAL KENYA

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Les retours optimisés de différents postes économiques dans des fermes familiales du Kenya central sont comparés en utilisant le calcul des marges tenant compte des contraintes terre, travail et capital. Les mêmes comparaisons sont faites pour une amélioration de 50% de la production laitière et une augmentation de 100% du prix du café. Les données de production utilisées pour les analyses proviennent de 90 exploitations laitières familiales du district de Kiambu (Kenya) entre juin 91 et juillet 92. Les fermes ont été sélectionnées par un échantillonnage aléatoire stratifié à 2 niveaux parmi les membres actifs de 15 coopératives laitières. De plus, au cours de la dernière visite mensuelle, des données économiques spécifiques concernant l'atelier lait et les autres postes de l'exploitation ont été collectées par questionnaire dans 80 fermes parmi l'échantillon de départ. La superficie en maïs et horticulture nécessaire pour la subsistance, et les valeurs des résidus de récoltes et du fumier relevées dans quelques fermes ont également été inclus dans le modèle d'optimisation. Bien que beaucoup d'autres hypothèses relatives au risque, à la saisonabilité des ressources et aux synergies entre les différents postes intra-exploitations n'aient pas été incorporées dans le modèle, les résultats suggèrent que la production laitière fournit la plus forte marge globale, et l'augmentation de cette production est la manière la plus efficace pour contribuer à l'intensification de ces fermes. Les implications de ces hypothèses nécessaires à une optimisation globale sont discutées.

INTRODUCTION

Farming in the central highlands of Kenya is dominated by mixed smallholder crop-dairy systems. On these farms, farmers grow crops for subsistence and for sale and typically keep a median of 2 cows and their followers, of mostly *Bos taurus* genotype, on approximately 2 acres of land. Crops grown on this same land include maize, coffee, and horticultural produce. The aggregate number of dairy cattle kept by these smallholders is estimated at 3 million head; approximately 30% of all Kenyan cattle and these contribute more that 75% of all milk produced in Kenya (Mbogoh, 1984). Support targeted at improvement of these smallholder mixed farms is expected to yield several economic and social benefits including, satisfying increasing urban demand for milk, increased incomes to the smallholders, and increase in rural employment opportunities (Brumby and Scholtens, 1986). In addition, mixed farming is considered essential for the long-term sustainability of the soils in the highlands through nutrient cycling (Powell et al., 1995).

Presently, dairy productivity on these farms is low, with milk production of only approximately 5 kg per day (Omore et al., 1996a) and high calving interval of 633 days (Odima et al., 1994). Several factors are suspected to contribute to this low production. The most important is suspected to be limited dry matter intake (Omore et al., 1996b). However, the relative importance of socio-economic constraints influencing the low dairy production have not been quantified. This paper attempts to compare the gross margins from dairy and major crop enterprises in these farms, given limiting resources of land, labour and capital.

MATERIALS AND METHODS

Production and survey data used for the analysis were gathered from 90 smallholder dairy farms in Kiambu District, Kenya between June 1991 and July 1992 inclusive. Farms were selected in a two stage stratified random sample from active members of 15 Dairy Cooperative societies. In addition, during the last monthly visit, specific economic data (including input and output prices, labour and household budget) relating to the dairy and other farm enterprises were collected by questionnaire from 80 of the original 90 farms.

Annual gross margins from dairy and the three main crop enterprises of maize, horticulture (mostly vegetables) and coffee were calculated (Table 1). A gross margin estimated for the dairy enterprise, earlier obtained using a livestock productivity index (Omore, 1996), was used. Using a whole farm linear program, these gross margins were optimised under different scenarios. The constraints included were land, operating capital and labour. Prices of farm products were adjusted to end-1996 values. Complimentarities between dairy and crop enterprises was incorporated by estimating the equivalent biomass of land under forage that crop residues provided and increased crop production from manure. Crop residues available for livestock feed were estimated to be 3000kg per acre per year (Kossila, 1987). The increase in crop production per acre from one cow's manure was estimated at 10%. Household consumption was considered by incorporating minimum values of land and labour

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that are required to provide maize and horticultural produce for subsistence for one year. Only integer increases in the number of cows was allowed.

Several factors that influence farmers' decision making and resource allocation were not fully incorporated in this analysis and the results must therefore be interpreted with caution. These include risk, variation in land potential, seasonality of available resources and the full extent of the synergy among farm enterprises. The possible implications of these assumptions are discussed below.

The comparison of optimised gross margins under current dairy production provided one scenario. In addition, two other scenarios of 50% increase in milk yield and a doubling in the price of coffee were compared in Scenarios 2 and 3 respectively.

RESULTS

The current un-optimized resources and production are presented in Table I. Under current production, the gross margin from the dairy enterprise accounts for approximately 50% of whole farm gross margin.

Table I
Resource allocation and gross margins of enterprises in smallholder farms in central Kenya

Constraints	Dairy	Maize	Hortic.	Coffee	Total	Max.	Min. Maize	Min. Hortic.
Unit	1.0	1.0	1.0	1.0				
Land (acres)	0.33	0.90	0.23	1.00	2.46	3.00	0.10	0.03
Labour (manhrs/yr)	900	848	1060	1500	4308	7455	85	106
Operating capital (KSh/yr)	6010	2000	3000	2000	8010	24802	0	0
Annual gross margin (KSh/yr)	24206	8000	13000	6000	**51206**			

The optimised values under the three scenarios are presented in Table II. Optimised gross margin with current resources and level of production would more than double the current whole farm gross margin (Table II), with most resources being allocated to dairy. The acreage under horticulture is drastically reduced and maize production is minimised to what is required for subsistence only. Coffee is removed as a viable enterprise. Dairy production is optimised with 4 animal units (a cow and its followers), giving a KSh. 101,825 (US$ 1850) annual gross margin (87% of total optimised gross margin). This optimisation suggests that capital is the most limiting resource and that extra income from increased milk yield should be invested in utilising the extra labour and planting the slack land available with horticultural produce, until it is possible to add another cow.

An increase in the price of coffee by 100% from the current low levels (a realistic possibility given the high fluctuations in world coffee prices) would result in utilisation of all slack land available but only a marginal increase in whole farm gross margin (Table II).

Table II
Optimization of gross margin under current production (Scenario 1), 50% increase in milk yield (Scenario 2) and 100% increase in coffee prices (Scenario 3).

Constraints	Dairy	Maize	Hortic.	Coffee	Total	Max.	Min. Maize	Min. Hortic.	Slack values
Scenario 1:									
Unit	4.0	0.5	0.8	0					
Land (acres)	1.39	0.10	0.11	0	1.60	3.00	0.10	0.03	1.40
Labour (manhrs/yr)	3600	424	870	0	4894	7455	85	106	2561
Operating capital (KSh/yr)	21340	1000	2462	0	24802	24802	0	0	0
Annual gross margin (KSh/yr)	101825	4000	10667	0	**116492**				
Scenario 2:									
Unit	4.0	0.5	1.8	0					
Land (acres)	1.39	0.10	0.36	0	1.85	3.00	0.10	0.03	1.15
Labour (manhrs/yr)	3600	424	1934	0	5958	7455	85	106	1497
Operating capital (KSh/yr)	21340	1000	5473	0	27813	27813	0	0	0
Annual gross margin (KSh/yr)	150005	4000	23715	0	**177720**				

Table II (Cont'd)

Scenario 3:									
Unit	3.0	0.4	1.6	1.5					
Land (acres)	1.04	0.10	0.32	1.54	3.00	3.00	0.10	0.03	0.00
Labour (manhrs/yr)	2700	339	1657	2312	7008	7455	85	106	447
Operating capital (KSh/yr)	16230	800	4689	3083	24802	24802	0	0	0
Annual gross margin (KSh/yr)	76369	3200	20317	18498	**118384**				

DISCUSSION

This comparison has been done without considering the full extent of factors that smallholders consider in their decision making regarding which enterprises to engage in. The different scenarios therefore only provide an indication of what may happen if farmers had more operating capital at observed prices and available resources. Besides, circumstances on local smallholder farms are influenced by a host of other factors including seasonality in labour availability, closeness to markets, the potential of the land resource and unquantifiable synergy between farm enterprises. Farmers also tend to be risk averse and may opt to keep down cash expenditures, regardless of potential returns, even if more capital were available. When the cash is invested, the riskiness of each enterprise will also determine decisions on how much to invest. In addition, changes in technology may completely change the enterprise mix. Farmers also tend to be quite rational in allocating resources to competing activities, such that returns to factors (e.g., labour) are identical across activities.

Nevertheless, these results suggest that dairying is the most important activity for the economic welfare of smallholders, given the immediately available resources. They also suggest that increasing access to credit could increase production. This is a service that some dairy cooperative societies currently provide. However, what farmers can save to invest or receive in credit is limited by their animals' low production. Off-farm income is currently the only way that farmers alleviate this constraint. This analysis also suggests that there is still room for more intensification before land becomes the most important limiting resource and the intensification can be most efficiently increased through dairy production. Farming of horticultural produce (e.g., flowers) may be more profitable than dairying but capital requirements and management expectations for most industrial crops are beyond the reach of the majority of smallholders.

In a previous classification of constraints to dairy production (Omore et al., 1996b), nutrition and poor breeding management were listed as the most important. Increased productivity of the dairy herd by the amounts suggested is feasible with current available resources and management changes. This has been shown by the better performance of better managed farms which recorded significantly shorter calving intervals and higher milk yields (Van der Valk, 1992; Odima et al., 1994).

As dairy production increases, the importance of various constraints is likely to change. For example, diseases of intensification like mastitis, which do not greatly limit milk production currently (Omore et al., 1996a), are likely to become more important. We plan to model a milk production function to be able to further refine and rank constraints to dairy production including mastitis, forage, concentrate and calving interval. This may help us understand more about why mixed smallholdings are important and help them to decide how to allocate their resources in order to maximise benefits in terms of goods consumed, products sold and risk reduced within the intensifying production system they belong to.

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