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Competitiveness of Smallholder Milk Production Systems in Uasin Gishu County of Kenya

Michael B. Kibiego[1*] Job K. Lagat[1] Bockline O. Bebe[2]
1.Department of Agricultural Economics and Agribusiness Management, Egerton University, P. O. Box 536-20115, Egerton, Kenya
2.Department of Animal Sciences, Egerton University, P. O. Box 536-20115, Egerton, Kenya
* E-mail of the corresponding author: kibiegomb@gmail.com

Abstract
In Uasin Gishu County of Kenya the rapidly declining household land sizes are a pre-requisite to increased intensification in dairy production. Although various dairy production pathways are used by farmers in the County, it has not been established which one of them would be comparatively competitive to enhance commercialization process and lead to attractive returns to smallholders investing in milk production. The objective of this paper is to estimate competitiveness in the smallholder dairy production sector in Uasin Gishu County. Stratified sampling and proportional sampling followed by random sampling within the stratum were employed to select 246 smallholder dairy farmers. Zero grazing, semi-zero grazing and open grazing production systems are analyzed separately using the gross margin, net margin and return on investment. The results indicate that the gross margin and net margin in smallholder milk production (Kshs/liter) were significantly influenced by the intensification pathway adopted. The gross margin and profit per liter decreased with an increase in the level of intensification with free grazing system and zero grazing having mean profit of Kshs. 20.19 and Kshs. 8.25 respectively. The returns on investment for free grazing, semi–zero grazing and zero grazing milk production systems were 34.07%, 40.22%, 25.67% respectively. Intensive milk production is relatively more profitable, however profitability of milk production/liter however reduced with intensification due to the higher feed and labour costs in more intensive systems. In conclusion, smallholder dairy production was an economically viable enterprise in Uasin Gishu County. Milk producers need extension services and finance to improve on feed production and utilization technologies in order to increase their profitability. Suggested future works include determining the options of improving market access so that it's positive contribution to dairy competitiveness is strengthened.
Keywords: Milk production; competitiveness, profit and intensification

1. Introduction

The dairy industry of Kenya forms a significant part of the rural economy in the country accounting for 14% of agricultural GDP as well as being the primary source of livelihood for many smallholders who account for over 70% of the total marketed milk in the country (IFAD, 2006). The potential of increasing the contribution of livestock to the economy needs to be explored. Improving livestock productivity is key to achieving the Millennium Development Goals (MDGs) of cutting the proportion of people living in poverty from 22% to 11% by 2015 (GOK, 2005; Amoako, 2003; Pingali, 2004). This improvement can be achieved through promotion of new technologies that are competitive (Ellis, 1992).Available milk production technologies include free grazing, semi-zero grazing and zero grazing and their relative competitiveness needs to be evaluated.

Breeding options include the breeds, in-calf heifer and cull cow replacement costs, and the costs of artificial insemination (A.I.) and bull services. The dominant breed in the herd was considered. The breeds were categorized as: Friesian and its crosses; Ayrshire and its crosses; Guernsey and its crosses; and other genotypes. Breeds vary in terms of milk production levels and this has an effect on milk productivity and hence competitiveness of milk production. Herd health management is critical to reduce the risks of death and/or low milk productivity for the herd. This study considered both animal preventive and curative health costs.

Housing and equipment costs are critical for efficient milk production. Housing is needed for zero grazing units, feed and water troughs, calf pens and stores. Various equipment are required for routine management of the animals and also for milk handling at farm level and for marketing. Low investment in housing and equipment was hypothesized the reduce competitiveness through low milk production or milk losses. Finally, the intensification level of hired and family labour use was estimated to determine their costs. Labour is a critical factor of production that needs to be utilized efficiently to obtain competitiveness in milk production. The intensification pathways were evaluated to determine their influence on the competitiveness of milk production. Adoption of gross bred cows and complementary feed and management technologies along with labour supply and use of inputs is a significant determinant of per capita income (Nicholson *et al.*, 1999; Ahmed *et al.*, 2003).

In this study, competitiveness is a measure of productivity with which a dairy farm utilizes its human, capital and natural resources. The competitiveness of smallholder milk production was measured by technical and economic efficiencies of the dairy farms, cost of milk production per liter, and gross margin and profit per liter of milk produced. Production refers to the economic process of converting of inputs into outputs. A non-optimal use of production factors, which can be put forward for milk production, implies a technical inefficiency (Marchand, 2010), that is a measure of returns to input use. Returns to capital invested were given by profit and gross margin analysis. Profitability considers the income from dairy farming, cost of variable inputs, paid costs for land and capital, and capital depreciation. The cost of milk production and profitability measurements enable the study to achieve the goal of determining intensification pathways influencing competitiveness of smallholder milk production in Uasin Gishu County of Kenya.

2. Literature review

In order to assess the link between the level of intensification and competitiveness in dairy farming in the Greater Nairobi milk-shed, two indicators were calculated (Baltenweck *et al.*, 2000). The first is the net cash flow derived from dairy activities; the second indicator is the return to family labour from dairying. Net cash flows are calculated as the sum of the income from milk sales and from sales of animals minus the cost of hired labour, feed expenditures, health services and purchases of animals (Baltenweck *et al.*, 2000). Because labourers do not work exclusively on dairying, only a portion of the total cost of hiring external labourers (corresponding to the proportion of hours spent working on dairy activities in the total number of working hours) is taken into account in the calculation of the cash flows. Net cash flows are calculated by household, per cow (net cash flows divided by the number of cows) and per ton of milk produced (net cash flows divided by the annual milk production). The second indicator is the return to family labour from dairy activities. This indicator takes into account the opportunity value of the milk consumed by the household and the opportunity cost of the feed produced on-farm. More precisely, the returns to family labour are computed as the cash flows calculated previously augmented by the market value of the milk consumed minus the rental value of land planted in fodder and pasture. Returns are calculated per farm, per cow and per ton of milk produced, in the same way as the net cash flows.

Kibiego *et al.,* (2015) utilized the Cobb-Douglas stochastic frontier production function to estimate the economic efficiency of smallholder milk production in Uasin Gishu County of Kenya while Tauer *et al*.,(2006) measured dairy farm cost efficiency. The two studies revealed that the economic efficiency increased with intensification. The Smallholder Dairy Project (SDP) used time series data from Kiambu, Nyandarua and Nakuru districts of Kenya to estimate costs, income and profitability of dairy enterprises as measures of competitiveness (SDP, 2000). The results showed that the cost of milk production rose as milk production systems became more intensive. The highest returns from the dairy enterprise were realized in the least-intensive system, in Nyandarua district, and lowest returns in the medium-intensive system, in Nakuru District (SDP, 2000). These returns would be even higher with inclusion of non-marketed benefits to the smallholder dairy enterprise.

Smallholder competitiveness in dairy production can be measured by efficiency and profitability (Staal, 2002; 2003; Wilson *et al*., 2011). According to Valk and Tessema (2010) and Staal (2002) the competitiveness of smallholder dairy production partially dependent on low opportunity costs for labour. However, other measures of competitiveness have been used. Delbridge *et al*. (2011) found an interesting implication of calculating farm profitability in that small conventionally managed farms may be able to earn greater net returns if transitioned to organic production instead of conventional use. A whole farm economic analysis was conducted to provide a detailed assessment into the economic, risk, and production implications due to the adoption of auto-steer navigation (Shockley *et al*., 2011). Automated steering (auto-steer) is a navigation aid that utilizes the global position system (GPS) to guide agricultural equipment. They determined that auto-steer navigation was profitable for a grain farmer in Kentucky, U.S.A. with net returns increasing up to 0.90% ($8.28/hectare). This study will measure competitiveness of the dairy production systems using profitability calculation.

3. Methodology

3.1. Study area

Uasin Gishu County was selected for this study because it is a leading milk producing area with the highest population of dairy cows in Kenya (GoK, 2010a). There are three dairy production systems/pathways and it covers both rural areas (Soy and Turbo Divisions) and a peri-urban area (Kapseret). The County had a human population of 894,179 persons and an average household size of 4.2 persons during the 2009 census (G.O.K, 2010b). The annual rainfall is 900 mm to 1,200 mm per year. For the purpose of this study, a smallholder dairy farmer is defined as one with at least one cow up to a maximum of 10 cows and an average of 2 hectares of land (IFAD, 2006).

3.2. Sample size determination

All the dairy farmers in Uasin Gishu County currently implementing the Smallholder Dairy Commercialization

Programme (SDCP) were the sample frame for this study as shown in Table 1. The SDCP records show that there were more than 10,000 dairy farmers and when sample frame is in excess of 10,000, Sekaran, (2006) recommends computing the needed sample size from:

$$n = \frac{z_{\alpha}^2}{d^2}pq \qquad = \frac{(1.96)^2(0.80)(0.20)}{0.05^2} = 246$$

Where,

n = the desired sample size, computed to 246

z = the degree of confidence chosen at 95% confidence interval.

p = the proportion in the target population estimated to have characteristics being measured (The smallholder dairy farms contribute over 80% of the marketed milk output in Kenya (Muriuki, 2001).

q = the proportion in the target population estimated to having no characteristics being measured (large scale dairy farmers).

d = level of statistical significance set at 5%.

Table 1: Distribution of the sample of the respondents

Production System	Population of Smallholders	Sample
Extensive	5,501	66
Semi zero grazing	11,626	138
Zero grazing	3,633	43
Total	20,760	247

Source: G.O.K., 2010b

3.3. Sampling procedure

Stratified random sampling was employed to select individual households proportionately to the population size in Uasin Gishu County using the list of dairy farmers in the office of the Divisional Programme Implementation Team (DivPIT). Stratification was by Division (Kapseret, Soy and Turbo Divisions) and production system (free grazing, semi-zero grazing and zero grazing). The respondents were chosen randomly from the selected strata. Whenever a selected smallholder dairy farmer did not respond, then the next one was chosen.

3.4. Data collection

Collection of data involved administration of pre-tested structured questionnaires, observations, focused group discussions and use of key informants. The study combined primary and secondary data. The data included the quantities and prices of all inputs and outputs of milk production. Outputs included milk and live animals sold. Inputs were feeds, breeding costs, herd health management costs, investment in housing and equipments and labour costs.

Under feeding costs, the value of own-produced feed, purchased forage and concentrates were measured in Kenya shillings. Breeding costs included in-calf and cull cow replacement costs, and bull and artificial insemination service costs. The cost of animal preventive and curative health costs per animal was measured in Kenya shillings to give the level of animal health management. Similarly, housing and equipment costs were valued. Hired and family labour used for milk production was quantified and valued in Kenya shillings.

3.5. Data Analysis

Gross margin analysis involved computing of the variable costs and revenue of milk production. The formula is given by Lipsey, *et al.,* (2004):

Gross Margin = Revenue - Variable costs.

According to Cramer *et al.,* **(**1985) and Lipsey, *et al.,* (2004), production of goods and services by firms cannot be done when total variable cost is greater than total revenue. But GM = R - TVC

Where GM = Gross Margin

R = Revenue

TVC = Total Variable Cost

This means that the gross margin derived by a smallholder farm is a measure of its performance. Revenue in this study considers the value of the milk produced on the farm.

In the case of milk revenue,

R = p.q

Where R = Revenue

p = Price of milk per litre

q = Milk output (litres)

Assuming that the smallholder dairy producers are operating in a perfectly competitive market structure, the only option for increasing revenue from dairy production is to increase milk output. The price, p, is determined by the market. Competitiveness will occur when the following condition is achieved:

$GM \geq 0$.

The higher the gross margin, the greater the level of competitiveness. So, for the purpose of this study, a smallholder dairy farmer is considered competitive if the gross margin of that farm is equal to or greater than zero. Hence, such a farm is not economically efficient when it has a gross margin that is negative.The profit function was given by (Garcia *et al*., 2008; Lipsey and Chrystal, 2004):

$$\prod_i = \sum y_{ij}p_{ij} - \sum x_{ij}w_{ij}$$

Where,

$\prod_i$ = Profit of the i-th dairy farm

y_{ij} = Quantity of j-th output in the i-th dairy farm

p_{ij} = Price of the j-th output in the i-th dairy farm

x_{ij} = Quantity of j-th input in the i-th dairy farm

w_{ij} = Price of the j-th input in the i-th dairy farm

Profit is given by total income less total costs of milk production. The gross margin and profit were calculated per liter for the three milk production systems.

4. Results

The gross margin and profit of producing one liter of milk was calculated for the three systems. Gross margin refers to the total income derived from an enterprise less the variable costs incurred in the enterprise. It enables producers to evaluate their existing enterprise performance, and for those who are contemplating investing in a new enterprise, it provides a guide to estimating the viability of the contemplated investment. Data collected on various components of the variable and fixed costs of production was classified into various categories for ease of analysis (Tables 2, 3 and 4). The feeds used by the milk producers included pastures, fodder, hay, silage, other roughage, dairy meal, other supplements and water. The cost of pastures was estimated using the value of renting pastures for 1 cow per month. The value for own labour as well as fixed costs associated with dairy enterprises were included in the analysis. The milk consumed by the household and the calf, and that which was sold was considered in the study as contributing to the revenue of the dairy enterprise.

Table 2 shows that in the zero grazing system, the cost of milk production was Kshs. 32.14 /liter. The gross margin and profit was Kshs. 9.58/liter and Kshs. 8.25/liter respectively. This production is associated with high cost of feed and labour. The zero grazing system gave 25.67% return on investments. The positive economic benefits are strongly supported by the milk price of Kshs. 40.39 /liter. The relatively high milk price suggests that this type of production system is common in urban and peri-urban settings with better market access.

Table 2: Gross margin and profit of milk production (Kshs/liter) in zero grazing system

item	unit	no. of units/ cow	no. of cows	cost/unit Kshs	value/cow Kshs	total value Kshs
Revenue						
Milk	liters	2,043.20	75	40.39	82,518.92	6,188,918.71
Variable costs						
Feeds	Kgs	658.11	75	67.74	44,581.57	3,343,617.44
Herd replacement						37,550.00
Health management						149,700.00
Labour						1,189,504.64
Total variable costs						4,720,372.08
Gross margin						1,468,546.63
Gross margin/liter						9.58
Fixed costs						
Depreciation on housing						191,680.00
Depreciation on equipment						12,810.00
Total fixed costs						204,490.00
Total production cost					65,664.83	4,924,862.08
Total production cost/liter						32.14
profit					16,854.09	1,264,056.63
Profit/liter						8.25
Returns on investments						25.67%

Table 3: Gross margin and profit of milk production (Kshs/liter) in semi-zero grazing system

item	unit	no. of units/ cow	no. of cows	cost/unit Kshs	value/cow Kshs	total value Kshs
Revenue						
Milk	Litres	1,012.69	423.00	28.67	29,038.04	12,283,091.42
Variable costs						
Feeds	Kgs	282.43	423.00	24.31	6,865.82	2,904,240.47
Herd replacement						91,900.00
Health management						181,529.33
Labour						5,445,198.46
Total variable costs						8,622,868.27
Gross margin						3,660,223.15
Gross margin/liter						8.54
Fixed costs						
Depreciation on housing						76,340.00
Depreciation on equipment						60,444.00
Total fixed costs						136,784.00
Total production cost					20,708.40	8,759,652.27
Total production cost/liter						20.45
Profit					8,329.64	3,523,439.15
profit/liter						8.23
Returns on investments						40.22%

Table 4: Gross margin and profit of milk production in free grazing system

item	unit	no. of units/ cow	no of cows	cost/unit Kshs	value/cow Kshs	total value Kshs
Revenue						
Milk	litres	650.08	915	28.09	18,258.86	16,706,860.64
Variable costs						
Feeds	Kgs	39.17	915	117.00	4,583.08	4,193,514.00
Herd replacement						99,900.00
Health management						228,069.38
Labour						62,118.40
Total variable costs						4,583,601.78
Gross margin						12,123,258.86
Gross margin/liter						20.38
Fixed costs						
Depreciation on housing						68,658.00
Depreciation on equipment						43,832.00
Total fixed costs						112,490.00
Total production cost					5,132.34	4,696,091.78
Total production cost/liter						7.89
Profit					13,126.52	12,010,768.86
Profit/liter						20.19
Returns on investments						34.07%

Table 3 gives the gross margin and profit calculations for the semi-zero grazing system. For one liter of milk, the cost of production, gross margin and profit was Kshs. 20.45, Kshs. 8.54 and Kshs. 8.23 respectively. This system had the highest return on investment of 40.22%. However, the profitability is constrained by the relatively lower milk price. The major costs of production are feeds and labour, just like in the zero grazing system. Free grazing system had a gross margin of Kshs. 20.38/liter and a profit of Kshs.20.19/liter as shown in Table 4. Here, the capital investment levels appear to be low. The return on investment was 34.07%. Producers using free grazing system faced a low milk price. But the cost of labour and feed was similarly low.

A comparison of the three milk production system shows that the free grazing system is the most profitable (Kshs. 20.19/liter), followed by zero grazing (Kshs. 8.25 /liter) and finally by the semi-zero grazing system (Kshs. 8.23 /liter). Households practicing the zero grazing and semi-zero grazing system incurred higher variable costs than the free grazing system. As expected, the cost of milk production was higher for the more intensive dairy production systems. Consequently, the gross margin in the zero grazing system was lower. These results are consistent with those of Mburu, *et al.* (2007) showing that in a zero grazing system, "on average, revenues significantly exceeded costs and the dairy enterprise returned a profit'. Using gross margin analysis, Wambugu *et al.* (2011) showed that dairying is an economically viable enterprise in the short-run, with the non-zero grazing system having higher gross margins and therefore, a financial advantage. This study has shown that free grazing had the highest gross margin. By giving an example of zero grazing for farmers selling milk through the Githunguri Farmers' Cooperative Society in Kenya, Wambugu *et al.* (2011) indicated that this system can perform well under conditions of collective marketing, good linkage to markets in terms of processing, access to production information, credit as well as other benefits. Therefore, if the zero grazing system is faced with similar milk price levels like free grazing, then the latter would be more profitable. Intensification of milk production needs to be accompanied by an efficient milk marketing system. The present study corroborates with that of Biradar *et al*. (2012) where herd replacement, herd health management and depreciations costs are minimal in the three milk production systems. Similarly, Mogaka (1993) found that labour was the major production cost (46%) followed by supplementary feeds (27.5%) and animal health (10.4%).

This study found out that feed costs are the largest in the three production system compared to the other costs. Feeds constituted 67.89%, 33.15% and 89.30% of the cost of milk production per liter in zero grazing, semi-zero grazing and free grazing system respectively. Feeding constitutes the largest portion of the costs of milk production in market-oriented dairy farming and dairy animals in Kenya are underfed, resulting in low milk yields (Muriuki, 2011). Thus the United States Department of Agriculture uses feeds cost to estimate Livestock Gross Margin-Dairy (LGM-Dairy) which is a risk management tool that enables dairy producers to purchase insurance against decreases in gross margin (Burdine, 2014).

The feed costs are lower in the free grazing system, but farmers then become susceptible to the effects of seasonal weather patterns. The price of milk that dairy producers receive is variable. Techno Serve Kenya (2008) reported a farm-gate price of Ksh 14 - Ksh 22 per liter and the informal market at Ksh 18 - Ksh 26 per liter. These milk prices are comparable to those received by the milk producers in this study.

5. Conclusion

The profitability of milk production/liter reduced with intensification due to the higher feed and labour costs in more intensive systems. In conclusion, smallholder dairy production was an economically viable enterprise in Uasin Gishu County. Milk producers need extension services and finance to improve on feed production and utilization technologies in order to increase their profitability. Further research is needed to determine the options of improving market access so that it's positive contribution dairy competitiveness is strengthened.

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