SDP Research and Development Report 1

Costs of milk production in Kenya

Estimates from Kiambu, Nakuru and Nyandarua Districts

Smallholder Dairy (R&D) Project
PO Box 30028
Nairobi, Kenya

Ministry of Livestock and Fisheries Development (MoLFD)

Kenya Agricultural Research Institute (KARI)

International Livestock Research Institute (ILRI)

Department for International Development-UK (DFID)

SMALLHOLDER DAIRY PROJECT

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Costs of milk production in Kenya:
estimates from Kiambu, Nakuru and Nyandarua Districts

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List of acronyms

CRC	Capital Recovery Cost
DFID	Department for International Development
GDP	Gross Domestic Product
GIS	Geographical Information System
ILRI	International Livestock Research Institute
KARI	Kenya Agricultural Research Institute
MoLFD	Ministry of Livestock and Fisheries Development
NDDP	National Dairy Development Project
SDP	Smallholder Dairy Project

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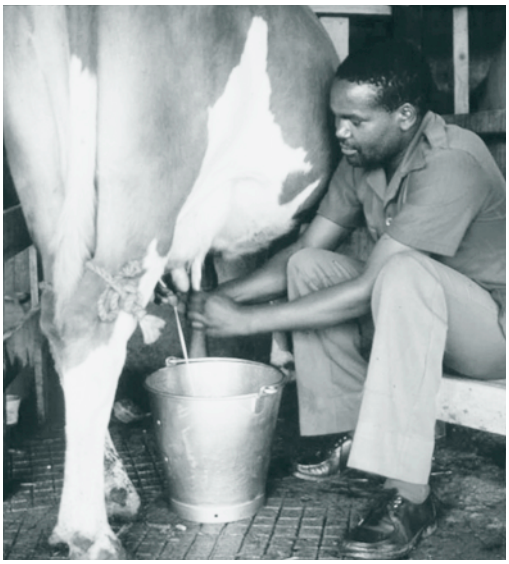
Executive Summary



The studies reported here were carried out by the Smallholder Dairy (R&D) Project (SDP) in response to the needs of Kenya dairy industry stakeholders for more reliable estimates of the costs of milk production in the country. These estimates are important for policy makers, development planners and donors when making decisions related to investment in dairy development compared to other enterprises, and for the design of policies to support smallholder dairy development. Moreover, significant falls in producer milk prices observed in early 2002 led to complaints from dairy farmers and wide media coverage, which further justified an investigation into the costs of milk production.

Data for the cost estimates were obtained during detailed in-depth studies of selected representative dairy farms in Kiambu, Nakuru and Nyandarua Districts between October 1997 and March 2000. Each farm was visited twice weekly over some 14 months to obtain daily records of inputs, outputs, purchases and sales. Kiambu District represents the most intensive dairy production system of the three, with good market access because of its proximity to Nairobi and good agroclimatic potential. The Nakuru site is second in production intensity level and is characterised by medium market access and medium agroclimatic potential. Nyandarua

represents the least intensive production system with good agroclimatic potential but poor market access due to distance from urban centres and poor road infrastructure. A total of 21 farm households were surveyed in Kiambu and 11 each for Nakuru and Nyandarua. In order to assess the cost and profitability circumstances under the conditions of low producer milk prices that occurred in early 2002, current input and output prices were obtained in April 2002. While requiring some simplifying assumptions, these updated estimates allow for some understanding of the level of change in profitability during adverse seasons.

Budget analysis was used to estimate cost of production, which incorporated all purchased inputs, equipment and services, the cost of family labour and land, and the revenues from the sale or consumption of milk and the sale of culled animals. The results show that at the time of the initial surveys, the cost of production was highest in Kiambu, at KSh 17.20 per litre, and lowest in Nyandarua, at KSh 11.90, with Nakuru in between at KSh 13.38. Milk prices received differed in the same manner, averaging KSh 17.60, KSh 15.20 and KSh 14.20 for Kiambu, Nakuru and Nyandarua, respectively. The results show that in all three cases there was a significant profit to the dairy enterprise, even after accounting for the costs of family labour. Unit profits were marginally highest in Nyandarua at KSh 4.75 per litre, followed by Kiambu with KSh 4.09 and Nakuru with KSh 3.60 per litre. These are above-normal profits since they occur even after family labour has been paid, and suggest a solid basis for profitable dairy production by smallholders in Kenya even under differing levels of intensification. The results underline the important role of smallholder dairy production in sustaining rural livelihoods, demonstrated here to in essence pay wages higher than those otherwise locally available.

Using price data for April 2002, a period that was characterised by apparently significant milk surpluses due to favourable rains, and assuming no change in input/output ratios, the results show unit losses of up to KSh 1.20 per litre in Kiambu, where cost of production was highest. These results point to the underlying risks inherent in smallholder milk production where output and input prices are purely market set, and where seasonal changes in rainfall and demand can dramatically alter farmers' fortunes, albeit mostly in the short term. Nevertheless, the more detailed data available from 1997 to 2000 demonstrate clearly the strong underlying competitiveness of smallholder dairying even in the central parts of Kenya where milk prices are often some of the lowest. The analysis does not attempt to incorporate non-marketed benefits to dairy farmers, such as the value of cattle as assets and the value of cattle manure applied to crops, which would even further raise the returns and level of competitiveness of smallholder dairy farmers.

Introduction

With at least 3 million improved dairy cattle[1], most of which are kept by smallholder farmers, Kenya is one of the developing world's most successful milk-producing countries. Central to that success has been not only the strong local culture of milk consumption, but also the favourable agroclimate of its tropical highlands.

In areas of high population density, this has allowed the development of highly intensive smallholder dairy production systems typified by the 'zero-grazing' practice of confining and stall-feeding cattle with crop residues and planted fodder, particularly Napier grass. In areas of greater land availability, such as parts of Rift Valley Province, less intensive feeding practices of combined grazing and stall-feeding, or only paddock grazing, are employed. Thus, farmers choose feeding systems which best utilise their relatively most scarce resource: land in the case of zero-grazing, and labour in the case of paddock grazing. Costs of milk production in turn reflect this substitution of primary inputs.

Because dairy production forms such a significant part of the rural economy, accounting for 33% of agricultural Gross Domestic Product (GDP) (Omiti and Njoroge 2002), and is the

[1]Dairy cattle are here regarded as those with some significant degree (at least 50%) of exotic dairy genes. While cattle of all types, as well as goats, sheep and camels, produce milk for human consumption, by far the greatest proportion of the milk produced in Kenya is from dairy cattle.

primary source of livelihood for over 600,000 smallholder farm families (Omore *et al.* 1999), there is continual interest from the public and from policy-makers in the profitability and competitiveness of Kenya dairy production. This was particularly true during the mid-1990s to the early 2000s, a period which was characterised by economic stagnation and decline. Average annual growth in real GDP for the period 1996–2000 was only 1.8% (World Bank 2002). A number of studies in the 1990s estimated production costs and profitability of smallholder Kenyan milk production. For example, Sellen *et al.* (1990) estimated returns to smallholder dairy farming in Nyeri at KSh 3.10 per litre. In an update from the same District, Staal (1995) estimated profits of KSh 2.80 per litre in 1992. During the early 1990s, the National Dairy Development Project (NDDP) estimated the cost price of milk in Nyeri at KSh 7.00, suggesting a loss of KSh 1.84 per litre.

In 1992, Waithaka and Nijssen showed an average cost of KSh 7.04 per litre in 14 districts covered by the NDDP's zero-grazing project against producer prices of KSh 5.20. In 1995, Maina and Waithaka showed average costs of KSh 12.91 in 25 districts under the zero-grazing system.[2]

However, since the mid 1990s no reliable estimates of the cost of milk production in Kenya have been published. In the meantime, liberalisation of urban milk markets and reduced public support to livestock services have altered the structure of the milk market and, potentially, the relative prices of outputs and inputs. Owango *et al.* (1998) showed that real milk prices to farmers in central Kenya rose significantly during the early 1990s as a consequence of market liberalisation, but it is uncertain whether that trend has been sustained.

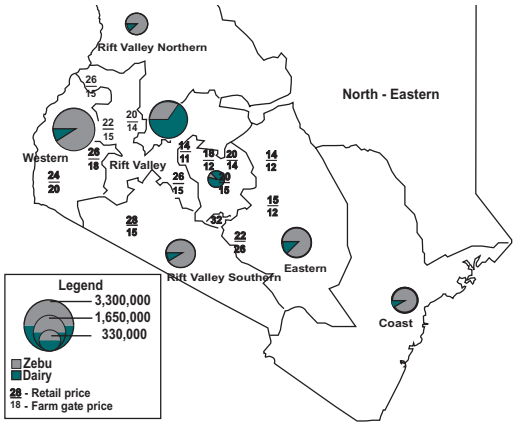
Given the lack of accurate information, it is useful therefore to re-evaluate the competitiveness and profitability of smallholder dairy production in Kenya. This report presents results based on data obtained from several detailed "longitudinal"[3] studies conducted by SDP in Kiambu, Nakuru and Nyandarua Districts between October 1997 and March 2000. Because budget data collection based on single-farm visits suffers from the difficulty of farmer recall over the entire annual period needed to capture seasonal changes, longitudinal monitoring was used to obtain more accurate data than is otherwise possible. The results presented in this report were derived from hundreds of observations over the course of an entire year for each of the farms monitored, and can thus be considered accurate data. In order to assess the potential impacts of the milk surpluses and low farm-gate prices subsequently observed in early 2002, follow-up surveys were conducted to update price information, and the budgets were updated to reflect new prices. Thus, this report presents both the results of the original surveys, based on complete data sets, as well as the results of the simulated budgets based on the new market prices observed in April 2002.

[2]Devaluation of the KSh in 1993 caused some costs such as dairy meal, to rise steeply, accounting for these differences in production cost estimates over a period of a relatively few years.

[3]Longitudinal studies refer to those that gather information from the same set of respondents through repeated visits over a defined period of time.

Determinants of milk prices in Kenya

FIGURE 1. Retail and farm-gate milk prices, and cattle populations by Province/Region, 1997.



Source: MoLFD and SDP figures, 1999.

Before addressing the cost of milk production and its profitability, it is useful to obtain a clearer picture of the factors that determine farm-gate milk prices across the rural areas of Kenya. Market prices are, of course, reflective of a number of supply, demand and policy factors. Not only do they reflect local supply and demand for milk, but also the costs involved in moving milk to larger demand centres in urban areas, which lower the prices received by farmers.

These costs include not only the cash costs of transport, labour and processing, plus a reasonable profit, but also the unobserved costs of the risks posed to buyers and sellers of non-delivery and non-payment, among others. Local supply depends on the density of dairy cattle and their productivity, which in turn depends partly on agroclimatic conditions, including rainfall and animal-disease challenge. Local demand is a function of human population density and milk and dairy product consumption habits. All of these combine to determine farm-gate and retail milk prices in a given area.

National milk price patterns

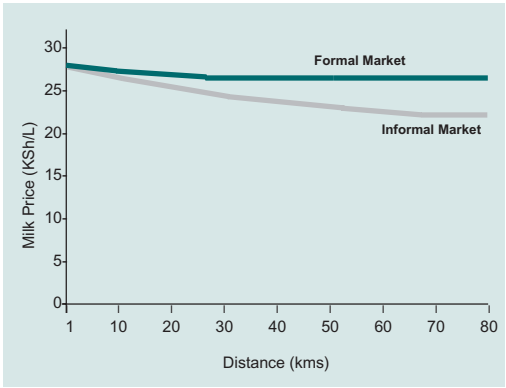
Figure 1 shows patterns of retail and farm-gate milk prices from key informant surveys conducted by SDP in 1997, and cattle

populations by province for the same period. Although absolute or nominal prices have changed since then, the patterns of price differences are likely to still be very similar. The highest prices were observed in the western parts of the country, which are known to be milk-deficit areas with high human populations and mostly zebu cattle populations, so that milk demand outstrips supply. As can be seen from the figure, however, the west also has the largest number of zebu cattle. Some of the lowest prices (farm-gate prices of KSh 11 or 12 per litre and a retail price of KSh 14 per litre) were observed in some parts of Rift Valley and Central Provinces where large dairy cattle populations and higher productivity contribute to sustained milk surpluses that have to be transported out to urban demand centres through intermediaries or processors.

Effects of distance on farm-gate milk price

In areas of significant milk surplus, where most milk must be transported to urban centres to be sold, transportation costs can have a significant effect on the price farmers receive for their milk. To examine this effect, SDP conducted a spatial analysis of milk prices using data obtained from separate large random cross-sectional household surveys in rural areas, as well as data derived from GIS (Geographic Information Systems) sources (Staal *et al*. 2001b). The formal[4] and informal[5] milk markets were considered separately, given the different market channels they follow. Using this analysis, estimates were made of the per-litre change in milk price for each kilometre of road that separated a farm from Nairobi. Figure 2 shows the distance decay functions estimated from the regression analysis of milk price formation expressed as a function of distance to Nairobi by main tarmac road. As can be seen, prices in the informal market fall more quickly with distance. In the informal market, at 75 kms from Nairobi, the effect of distance on milk price is maximum, with a fall in price of approximately KSh 6 per litre, which represents approximately one-fifth less than the mean informal market price in Nairobi (which is KSh 27.8 per litre). The maximum predicted fall in the formal market price is about KSh 2 per litre. These differences do not necessarily

FIGURE 2. Effect of road infrastructure and distance on milk prices in the formal and informal milk markets in Kenya.



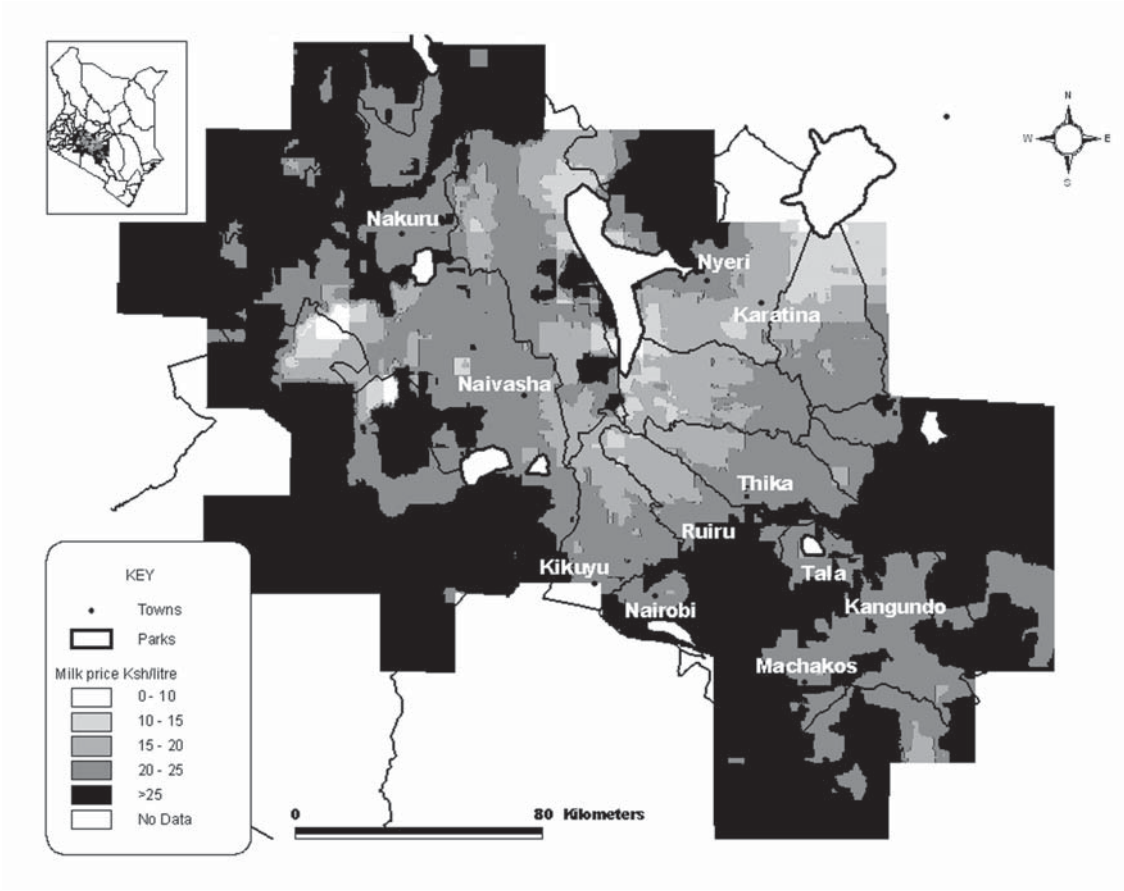
Source: *Staal et al. 2001b.*

[4] *Formal milk markets can be defined as those that follow modern Western-style processing technology, and conform to milk market regulations and licensing.*

[5] *Informal or indigenous milk markets can be regarded as those that handle mostly raw milk and traditionally processed products, and may not conform to all milk market regulations.*

suggest, however, that informal markets operate less efficiently per kilometre than formal markets, only that informal market prices paid to farmers more explicitly reflect actual transport costs and associated risks. This is because the formal market tends to offer uniform prices at the main collection centres, regardless of distance. The conclusion is that formal markets are important for providing reasonable milk prices over large areas. Informal markets, while offering higher prices to farmers, are limited in the range they operate, as they are unable or unwilling to subsidise the price for distant farmers, as the formal markets are effectively doing. The key point here, however, is that in the informal markets, on which most farmers in Kenya depend, distance to urban centres results in significantly lower farm-gate prices.

FIGURE 3. Predicted informal market farm-gate milk price in the area of survey, based on road distance and agroclimate (other variables held fixed at mean).



Source: *Staal et al. 2001b.*

FIGURE 4. Monthly milk prices received by monitored farms in the three study sites, weighted by volume.

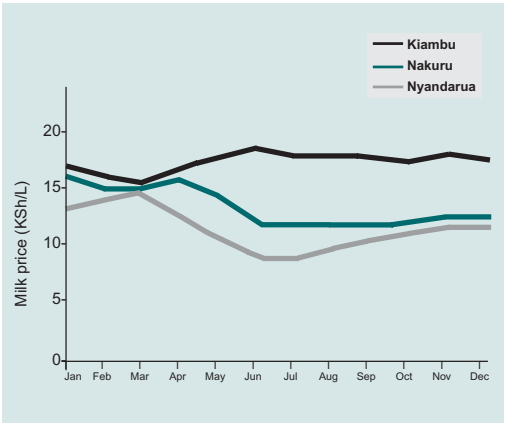


Figure 4 shows the seasonal patterns in milk prices observed among the farms monitored in the three study districts. As expected, prices fell during the flush seasons in Nakuru and Nyandarua, although prices remained steady in Kiambu, probably due to its easy access to strong urban markets. The largest seasonal differences occur in Nyandarua District, where the price in July was 19% lower than the peak price in March.

Based on the estimates of the effect of road distance on farm-gate milk price, GIS methods can be used to map the expected milk prices in different parts of the country. Figure 3 shows those predicted milk prices, based not only on distance but also on agroclimatic potential, which was measured using an index of rainfall and temperature. The map clearly shows the low milk price zones of Central and Rift Valley Provinces, with higher prices obtaining in outlying areas of higher milk deficit.

Seasonality in milk prices

An additional factor influencing milk prices is seasonality, primarily changes in rainfall that influence the availability of forages for dairy cattle. The season of peak milk production, or 'flush' season, is typically associated with the rainy season of April–June. During this period, increased supply tends to drive down prices received by farmers.

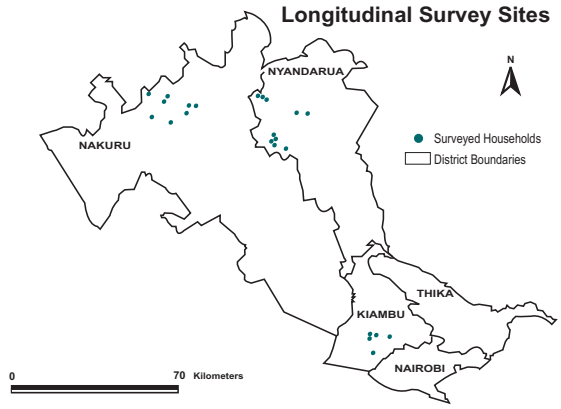
Data and methodology

Data sources

Data were gathered from representative dairy-farm households in the three study districts. The households were selected based on random cross-sectional surveys of 365 households in Kiambu (Staal *et al.* 1997), and of 1,390 households from across a number of districts in central Kenya (Staal *et al*. 2001a).

Combined principal-component and cluster analyses were employed to identify representative groups of dairy farms in terms of resources, market orientation and feeding strategy. From among those groups, a smaller number of typical farmers were selected based on their individual farm characteristics falling close to the mean for the group. A total of 21 farm households were selected and monitored from four divisions in Kiambu: Limuru, Kiambaa,

FIGURE 5. Map of survey sites with location of monitored households.



Githunguri and Kikuyu. In both Nakuru and Nyandarua Districts, 11 farms were selected and surveyed, all of them being from one division in each case: Rongai and Ol-Kalau, respectively. Figure 5 shows the location of these study sites.

An enumerator was assigned two, three or four farm households located within an area measuring no more than 5 km^2. The enumerator administered a structured questionnaire to each farm household twice a week from October 1997 to December 1998 in the case of Kiambu, and November 1998 to March 2000 in the case of Nakuru and Nyandarua, respectively. This was intended to ensure that seasonal variability in parameters such as prices, costs and fodder availability was captured. Based on farmer recall over the few days since the last visit, daily data were collected on the following: milk production, sales and consumption; milk-buyer type and prices paid to the farmer; quantities of feed and fodder used; purchase prices for feeds and other farm inputs; and cattle inventory changes through births, sales, purchases or deaths. In addition, data were collected on the amount of hired labour used and its cost, type

TABLE 1. Characteristics of the monitored farms: mean household values for some descriptive parameters.

Parameter	Kiambu (n = 21)	Nakuru (n = 11)	Nyandarua (n = 11)
Household members	7.2	8.4	6.3
Acreage per household	3.0	7.8	11.4
No. of dairy cattle	3.1	3.5	2.4
No. of cows	1.9	2.8	2.7
% of land under crops	86.1	55.7	27.6
% of land under pasture	2.6	35.5	70.7
% of land under other planted fodder	0	11.0	2.2
% of land under Napier grass	15.2	3.8	0.9
Annual cattle mortality rate (%)	18.5	23.0	19.6
Labour to the dairy activity (hr/yr)			
Hired casual labour	216	108	218
Hired long-term labour	216	901	673
Family labour	1,104	2,417	1,965
Milk utilisation (% of milk)			
Household consumption	21.3	21.0	29.5
Calves	8.1	9.1	13.7
Sales	70.6	69.9	54.8
Channel through which milk is sold (%)			
Local dairy or cooperative society	65.0	< 1.0	< 1.0
Private processors	4.0	23.0	72.0
Trader/hawker	7.0	64.0	21.0
Farmer group	0.0	< 1.0	2.0
Local households	7.0	2.0	5.0
Local milk bars/hotels	11.0	4.0	<1.0
Kenya Cooperative Creameries (KCC)	< 1.0	4.0	0.0
Neighbours	6.0	3.0	< 1.0

and cost of veterinary drugs, and amounts of family labour used in different farm activities. Thus the data represented detailed information on daily inputs, outputs and prices over the course of the survey period for each farm.

In order to approximate the effect of changing prices observed subsequently in early 2002, brief follow-up surveys to some of the original farms were conducted in April 2002 to obtain current price data for inputs and outputs. At around that time, farmers in some areas in Kenya, including parts of the survey districts, had difficulty selling all their milk, with producer prices in some places being as low as KSh 8.50 per litre. Information was also gathered on current constraints to milk marketing, including in some cases milk buyers' imposition of quotas on milk sales by farmers.

Description of farms surveyed

The characteristics of the farms surveyed are summarised in Table 1. Of note is the increase in acreage per household from Kiambu to Nakuru and Nyandarua, accompanied by an increase in the proportion of land allocated to pasture. Labour use is higher in Nakuru and Nyandarua than in Kiambu due to the use of family labour for grazing. Kiambu displays a marked difference in the type of milk sales, with most milk going to dairy cooperatives, whereas in Nakuru most milk is sold to traders, and in Nyandarua to private processors.

Methodology for cost and revenue estimates

Partial budget analysis was used to compare cost of production and revenues. The partial budget analysis employed in this study differs from the more common method of making comparisons between or within enterprises on the implications of changing from one production strategy to another, e.g. changing from open grazing to zero-grazing systems. Quantities of inputs used and outputs obtained, sold and consumed were calculated as the mean of sampled households in each of the three survey areas. Similarly, prices are the mean calculated from data collected from individual sample farm households over the course of the year.

Estimation of fixed costs was performed using the capital recovery cost method, which takes into account the opportunity cost of capital. Money invested in the purchase of a capital item has opportunity cost equivalent to the rate of return in an alternative investment. Therefore, a suitable technique for estimating fixed costs is one that recovers the cost of capital over its useful life and pays a rate of return equivalent to the market opportunity cost. The capital recovery cost (CRC), is defined as the annual payment that will repay the cost of fixed input over the useful life of the input and provide an economic rate of return on the investment.[6] For the purpose of this study, the mean bank interest rate on savings deposits of about 4.5% prevailing

[6] *The capital recovery cost formula used in the estimation of the fixed costs for the dairy enterprise is:*

$$R = Z\left[\frac{(1+r)^n r}{(1+r)^n - 1}\right]$$

Where: R = capital recovery cost Z = initial outlay on the capital asset r = interest rate or the opportunity cost of the investment.

at the end of 2002 was used as the opportunity cost of funds invested in the dairy enterprise.

Family labour is valued at 80% of the reported casual rural wage in the area. This reflects the assumption that the opportunity cost of family labour is below the wage rate simply because off-farm employment is not always readily available to farm family members. Valuing family labour at the full wage rate would require the assumption that off-farm casual employment opportunities are available on every day during every season, which is not realistic.

Land is valued at the full reported rental rate and only land under zero-grazing units, pasture or cultivated fodder is included in the cost to the dairy enterprise. This cost of land is reflected in the cost of own-produced forage.

Food-crop residues gathered on-farm and fed to cattle are not costed, nor are forages gathered off-farm, although the associated labour costs are included. The value of manure produced by owned cows and used on farm as a soil amendment is not included, since quantities of manure applied were difficult to measure accurately. It should be noted however that the value of manure used on crops or planted fodder represents additional revenue to the farm as an intermediate input.

Revenues include sales of milk and the value of milk consumed by the farm family, and sales of cattle, whether culled cows, males or heifers.[7]

The value of milk given to calves and farm labourers is included under costs, but also under revenues since it is a product of the farm. Profits are mean revenues less mean costs.

[7] *The results reflect actual changes in herd structure and size during the survey period, through births, deaths and sales. If constant herd size was assumed, the estimated profit per litre could be reduced by up to KSh. 1.70 in Kiambu and 0.95 and 2.00 in Nakuru and Nyandarua respectively, because sales exceeded births during the survey period.*

Results

Two sets of results for costs of production and profits are presented here. The first set uses all the detailed household data from the longitudinal surveys conducted between October 1997 and December 1998 for Kiambu District, and between November 1998 and March 2000 for Nakuru and Nyandarua Districts, respectively, with unadjusted prices.

These are considered to be reliable results for the period in question, and are the main emphasis of this report. However, since some milk price changes were witnessed in early 2002, another set of results is presented in which prices from April 2002 are applied to quantities of inputs and outputs computed from the longitudinal survey data. The assumptions needed to make the latter estimates, and the caution thus required in considering those results, are discussed below.

Estimated cost of production and profitability

Cost of production is expected to be highest in the most intensive system and to decline as the feeding systems used become more extensive, reflecting the costs of the high-concentrate feed used in the more intensive systems. This expectation is borne out of cost of production being highest in Kiambu at KSh 17.20 per litre, lowest in Nyandarua at KSh 11.90 per litre, and intermediate in Nakuru at KSh 13.30 per litre.

TABLE 2. Average costs of milk production, price received, revenue and profit at the three study sites.

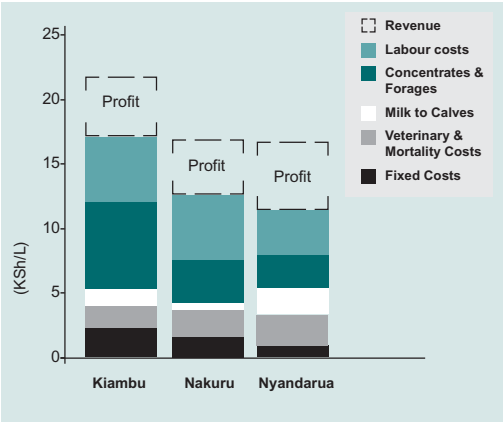
KSh	Kiambu (1998)	Nakuru (2000)	Nyandarua (2000)
Cost of production per litre	17.2	13.3	11.9
Sale price per litre	17.6	15.2	14.3
Revenue per litre*	21.3	16.9	16.7
Profit (KSh per litre)	4.1	3.6	4.8
Revenues from milk (%)	83.0	90.0	86.0
Revenues from animal sales (%)	17.0	10.0	14.0

**Revenue in a dairy enterprise accrues from sale of milk and animals, and milk consumed by household.*

Thus these cost-of-production figures reflect the different levels of dairy intensification in the three survey sites. Summaries of these estimates are presented in Table 2; details of the farm budgets are given in the Appendix.

On average, the cost of milk production is 44% higher in Kiambu than in Nyandarua, reflecting particularly the costs of the greater quantities of concentrate feed used. This is demonstrated in Figure 6, which compares components of costs of production across the three study sites per unit of milk produced. The unit revenue bar has been overlaid on the cost bar for comparison.

FIGURE 6. Cost (KSh per Litre) of milk production and its components at the three study sites.



As shown in Figure 6, other differences include high costs of own-produced forage in Nyandarua, which reflects the relatively large land area allocated to low-yielding pasture. Veterinary costs are also high in Nyandarua due to the greater tick-borne disease challenge faced by cattle that primarily graze, and the costs associated with mortalities were highest in Nakuru. Family labour and hired-labour costs do not differ substantially across sites, while fixed costs are highest in Kiambu where greater investment is needed to build the zero-grazing units used there. The amount of milk retained on the farm for feeding to calves or to be given to hired labour is highest in Nyandarua and represents a substantial proportion of the cost there. This supports findings from the larger characterisation surveys (Staal *et al.* 2001a) that showed that in areas where milk marketing is a problem, such as the relatively remote extensive

areas of Nyandarua, forced disposal of milk is apparent, particularly of the evening milk, which is often not collected. The implication, then, is that with better access to milk markets this imposed cost would decline.

Comparing costs with revenues, we find a similar picture. Figure 7 compares milk price, unit cost of milk production, unit revenue and unit profits. Price is simply mean price per litre of milk sold, while revenue per litre is calculated by dividing total revenue from the sale of both milk and animals by the total milk produced, which leads to revenue per unit of milk being higher than unit milk prices. The pattern of milk prices closely matches that of costs, with prices being highest in Kiambu close to the main urban centre of Nairobi, and lowest in rural Nyandarua where collection costs are relatively high and milk surpluses greatest.

FIGURE 7. Unit costs, revenues, profits and milk prices at the three study sites.

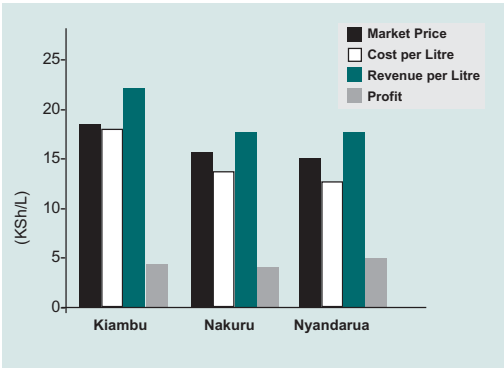


Table 2 and Figure 7 show that, on average, revenues significantly exceeded costs, and the dairy enterprise returned a profit at each of the three study sites. Profits ranged from KSh 4.75 per litre in Nyandarua to KSh 3.60 per litre in Nakuru, with Kiambu being in between. Interestingly, now the pattern of differences associated with greater intensification no longer holds. The extensive Nyandarua farms show the highest levels of returns, with intensive Kiambu next, and medium-intensity Nakuru last. Of note is the difference between milk price and revenue per litre of milk, which is comprised of the value of animals sold per unit of milk produced. Even in Kiambu, commonly regarded as specialising in intensive milk production, the value of culled animals makes up nearly all of the profit realised. Indeed, the milk price by itself only marginally covers the cost of production. In Kiambu, this difference is particularly large because revenues from animal sales amounted to some KSh 3.70 per litre of milk sold, or some 17% of revenues (Table 2).

The results demonstrate that different avenues and production strategies are available for obtaining comparable returns from milk production. Kiambu, with higher levels of intensification, and thus greater expenditure on purchased inputs, still returned higher profits than one of the areas with less-intensive systems, a reflection of the fact that higher expenditure on inputs was matched by corresponding higher-priced outputs because of proximity to urban consumption centres.

It should be noted that the 'profits' described here are in fact 'above-normal profits'. This is simply because the costs of family labour have already been deducted from these returns. Thus, these profits are those that are available after family labour has been paid, albeit at 80% of the

rural wage rate. These above-normal profits represent a form of supplemental wages for each family in the amount of on average KSh 12,094.00 for Kiambu, KSh 16,103.00 for Nakuru and KSh 18,032.00 for Nyandarua per household per year. Compared to the reported Kenya average per capita GDP of only US$371 in 2001 (World Bank 2002), or approximately KSh 27,825.00, these are significant additional returns. Viewed in terms of returns to family labour, the low-intensity production system in Nyandarua showed the highest efficiency of labour use. The results underline the important role of smallholder dairy production in sustaining rural livelihoods, demonstrated here to in essence pay wages higher than those otherwise locally available. Added to this is the employment created through casual and long-term hired labour on even the smallest dairy farms, contributing to livelihoods of others within the rural community, some of whom may be among the most resource-poor.

Non-marketed benefits

Although no attempt is made here to quantify them in the analyses presented in this report, it is important to take note of the non-marketed benefits to the smallholder dairy enterprise. These are primarily (a) the value of manure used on farm, and (b) the functions of livestock as security against contingencies and as a means of financing. In some cases, there is also value to farmers in simply keeping cattle because of the social status associated with cattle keeping.

Particularly in intensive production systems such as those in Kiambu, the value of manure used on food or cash crops on-farm may be quite significant. The nutrients and organic matter in cattle manure may allow sustained multiple cropping of small land holdings year after year while maintaining soil fertility with minimal other inputs. The fact that cattle are often fed concentrates or fodder brought in from off-farm means that cattle manure forms a nutrient channel from off-farm. Studies in Kenya have estimated that the value of manure may be some 30% of the value of milk sold (Lekasi and Tanner 1998).

The insurance function of livestock results from the potential of being able to sell the animals in case of emergencies. This insurance function is important not only in situations where no other means of storing wealth are available, but also because animals are easily convertible assets, even when there are other insurance options. The financing function is similar but separate—by providing a store of wealth that is resistant to inflation and that can be used for planned large expenditure, such as investment in farm infrastructure or in other business enterprises. Some related studies in Kenya suggest that these functions of livestock as assets could contribute another 19% to outputs (Ouma *et al*, 2003).

Combined, the tangible and intangible non-marketed benefits of keeping dairy cattle contribute significantly to farmer welfare, and in the long term to competitiveness of smallholder dairy systems in particular. Large-scale dairy farmers may have difficulty in capturing the same benefits since for them manure may be a liability that includes disposal costs.

Simulated estimates of cost of production and revenues, April 2002

In early 2002, there was considerable public debate in Kenya over falling producer milk prices, particularly in the main milk producing areas of Rift Valley Province and in some parts of Central Province. While many, including the media, claimed that milk-powder imports were to blame, official Ministry of Agriculture figures showed that between October 2001 and February 2002, the five months leading up to the low prices, milk-powder imports were in fact about half of what they had been over the same period the previous year. Instead, the low prices were more likely to have been a result of the fact that in that year the usual December–March dry season did not materialise in many areas, and therefore there was an abundance of forage for sustaining milk production, leading to milk surpluses. For example, in Kinangop, Nyahururu and Rongai, January 2002 rainfall was 2 to 4 times as heavy as the long term mean rainfall for that month, as reported by the Kenya Meteorological Department. In South Kinangop, it was 130 mm in January 2002, compared to an historical average of 29 mm. In addition to the low producer prices, in some areas milk processors and cooperatives placed quotas on the quantities that farmers could deliver, or declared 'milk holidays', confining farmers' milk deliveries to a limited number of days per week. Such restrictions on delivery have rarely been observed previously in Kenya.

In order to provide some assessment of the potential impact of the milk surpluses and low farm-gate prices that were observed in early 2002, input and output prices from April 2002 were applied to the input and output quantities derived from the 1997–2000 farm-monitoring exercises. This required the simplistic assumption that farmers would retain the same level of input use even with significant declines in output prices. In reality, however, farmers are likely to respond by reducing the amounts of inputs applied when producer prices decline.[8] This is particularly true if, indeed, the milk surpluses were mainly due to good continued rains, in which case the relative plentiful availability of forage on-farm that farmers could have substituted for purchased concentrates and forages. An additional assumption required for this estimate is that these seasonally low milk prices potentially reflect average annual prices for some particularly bad years. Thus, these results should be regarded as indicative of the potential scale of change in farmer returns with changes, mainly in milk prices, due to major supply shifts.

In order to illustrate the underlying price changes, Table 3 shows differences in key input and output prices, with percentage change indicated, between the survey period and the update carried out in April 2002. The largest percentage price changes are seen to have occurred in Nyandarua, where prices fell by 40% in nominal terms. Further, prices of some inputs rose, such as concentrate feed and casual wage

[8] *Anecdotal evidence obtained during the 2002 price survey supports the idea that farmers were indeed reducing input use during those periods of low milk prices. Farmers reported using less concentrates and supplements, and some even reported no longer using AI services.*

TABLE 3. Key input and output prices for the survey period and the update carried out in April 2002, and simulated estimates of changes in costs of production, revenues and profits.

	Kiambu			*Nakuru*			*Nyandarua*		
Item	*Survey*	*2002*	*% Change*	*Survey*	*2002*	*% Change*	*Survey*	*2002*	*% Change*
Cost of production per litre	17.2	21.1	22.7	13.3	15.4	16.2	11.9	12.4	4.2
Milk price per litre	17.8	15.8	-11.2	15.2	12.5	-17.8	14.3	8.5	-40.6
Revenue per litre	21.3	19.9	-6.5	16.9	14.4	-14.6	16.7	11.9	-28.8
Profit per litre	4.1	-1.2	-129.3	3.6	-1.0	-128.3	4.8	-0.8	-117.3
Dairy Meal (Ksh/ 70kg sack)	780.0	860.0	10.3	775.0	863.0	11.4	755.0	863.0	14.3
Casual wage rate	70.0	100.0	42.9	70.0	100.0	42.9	75.0	100.0	33.3
AI service (Ksh/service)	270.0	308.0	14.1	460.0	550.0	19.6	*	550.0	-

** None of the surveyed farmers in Nyandarua used AI services.*

rates, which rose significantly in nominal terms, unadjusted for inflation.

Production systems using relatively higher proportions of concentrates and supplementation experienced a sharp rise in unit cost of production compared to less intensive ones. Table 3 and Figure 8 present the estimates obtained that show negative overall profits for all three study sites.

The result follows the trend observed earlier with cost of production varying with level of dairy intensification. An important observation is that there is a disproportionate increase in the cost of production between the three sites, with the highest increase occurring for the Kiambu site. Input prices, especially of concentrates and veterinary drugs, had risen substantially in nominal terms, unadjusted for inflation between the time of the earlier surveys (1997–2000) and April 2002. Production systems with a higher proportion of these inputs in their cost structure show a correspondingly higher increase in unit cost of production. This is demonstrated in Figure 9, which shows unit costs and revenues.

Again, it should be noted that the profits referred to here are calculated after payment of family

FIGURE 8. Unit costs, revenues, profits and milk prices at the three study sites, simulated for April 2002.

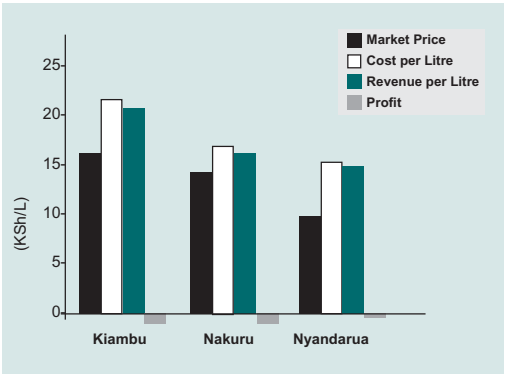
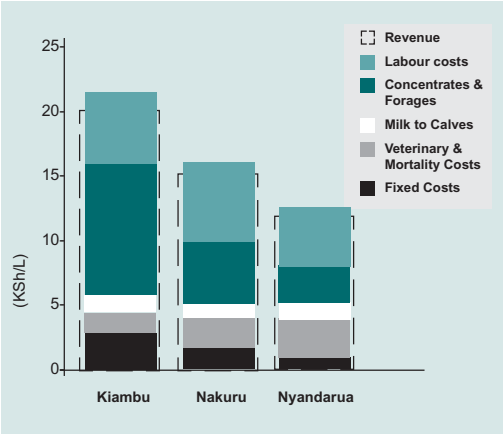


Figure 9. Cost of milk production and its components at the three study sites, simulated for April 2002.



labour. Thus, a negative profit is simply a reduction in the effective wage to family labour. Effective returns to family labour per household annually still amounted to KSh 8,414.00 for Kiambu, KSh 11,570.00 for Nakuru and KSh 14,740.00 for Nyandarua per annum, (despite the reduction in returns of KSh 3,680.00 for Kiambu, KSh 4,530.00 for Nakuru and KSh 3,290.00 for Nyandarua).

Conclusions and policy implications

The results from the longitudinally recorded full data sets (Kiambu:1997–1998; Nakuru and Nyandarua: 1998-2000), show clearly that smallholder dairy producers in Kenya are able to capture useful profits, and are likely to continue to be competitive. Based on the detailed daily household data, the dairy enterprise is demonstrated to provide above-normal profits, meaning that returns are higher than those available through rural wage labour. This is true for a range of production practices from intensive stall-feeding systems to extensive grazing systems.

The understanding that farmers also capture additional but unmeasured benefits from the use of manure, and from the insurance and finance values of livestock assets, further strengthens their returns and competitiveness. The resilience of smallholder dairy farming as a primary provider of livelihoods in many rural areas of Kenya cannot reasonably be questioned.

In the same way, the analysis of the patterns and determinants of farm-gate milk price underlines the important role that road infrastructure plays, particularly in the informal market that dominates the dairy sub-sector. Farmers 75 kms or more from Nairobi may get 22% less for their milk compared to farmers close to the urban areas. Other analyses not described here (Staal *et al.* 2001b) show that for each additional kilometre of poor feeder road that separates a farm from the main road milk price is reduced by some 47 cents per litre, or about 3% per kilometre. The analysis also showed that simply upgrading the poor feeder roads to good murram roads could reduce per km transport costs on those roads by 30%, and raise prices paid to farmers accordingly. Poor roads also significantly reduce farmer access to important support services, such as veterinary services and artificial insemination, which have further suffered from reduced public support since the early 1990s. Therefore, policies that target improvement of feeder roads and road infrastructure are likely to have a significant positive impact on the livelihoods of dairy farmers, particularly those in rural areas distant from major urban centres.

The simulation analysis of the seasonal price changes seen in early 2002 demonstrate, nevertheless, that under some supply conditions farmers in the main surplus areas can be adversely affected. Farmers using intensive production practices may be most vulnerable to these conditions. This may hint at greater long-term competitiveness of the extensive production systems if increased supply and stagnating demand lead to overall lower real farm-gate milk prices.

It is important to note that a few months after the perceived crisis in early 2002 because of the over-supply of milk and the resultant low farm

prices, public media and some officials declared the existence of the opposite situation, namely milk shortages (*Daily Nation*, 15 August 2002). It is clear that seasonal variation in milk supply, and consequently price fluctuations, will continue to occur intermittently, and will at times negatively affect farmers, especially those located in the main milk-surplus areas. Given the very low scale of milk powder imports (in recent years only some 0.5% of annual national production), the 60% duty placed on powder imports in March 2002 is unlikely to have a significant effect except on the small proportion of products that require a powder component. In the opening months of 2002 the particularly strong over-supply of milk and low market prices were perhaps a sign that larger structural changes were occurring in the milk sub-sector. Stagnating demand may be one cause, with economic decline contributing to lower disposable incomes and to reduced purchase of milk by some Kenyan households. Efforts to raise demand through, for example, donor-funded promotional campaigns about the benefits of drinking milk, may have limited success unless general economic conditions improve. Given the relatively high retail price of pasteurised milk (generally more than double the farm-gate price), efforts to reduce retail prices through more efficient processing and packing could be expected to have a greater effect in raising consumption.

Available evidence suggests that, for the foreseeable future, smallholder Kenya dairy farmers will continue to do well under a variety of production systems even though seasonal fluctuations may have temporary adverse effects on some groups. Significant farm-level profits, combined with continued milk deficits and high prices in some areas, particularly the western part of the country, suggest that public-policy support for smallholder dairy development will continue to be an effective means of improving farmers' welfare and livelihoods and for rural development.

Appendix –Estimated Dairy Enterprise Budgets

Kiambu District (survey period 1998)

Number of cows	1.94
Forage acreage (acres)	0.56
Total acreage (acres)	2.97
Milk output (Kg/yr)	2,958

Output	*Quantity*	*Unit*	*Prices*	*Ksh/yr*
Bulls	0.05	Heads/yr	20,000	1,000
Castrated adult males	0.00	Heads/yr	0	
Immature males	0.10	Heads/yr	6,750	675
Cows	0.25	Heads/yr	18,200	4,550
Heifers	0.30	Heads/yr	12,800	3,840
Male calves	0.05	Heads/yr	1,825	91
Female calves	0.10	Heads/yr	6,650	665
Milk sales	2083.00	Kshs/yr	17.6	36,718
Milk to household & relatives	635.00	Kshs/yr	17.6	11,187
Milk to calves & labourers	241.00	Kshs/yr	17.6	4,245
Total output				**62,971**

Fixed input	*Quantity*	*Initial costs*	*Useful life*	*CRC**
Cows	1.85	17,600	12	3,571
Dairy shed	1.00	25,000	15	2,328
Milk can	1.00	1,200	15	112
Milking bucket	1.00	700	10	88
Panga (machete)	1.00	190	12	21
Wheelbarrow	0.55	2,500	9	189
Handcart	0.05	10,000	10	63
Bicycle	0.55	4,000	10	278
Total fixed costs				**6,650**

Intermediate input	*Ksh/yr*
Purchased fodder	2,282
Cost of own produced forage	1,064
Concentrates	18,267
Veterinary costs	2,110
Total intermediate	**23,723**

Other cost	*Ksh/yr*
Mortalities	3,245
Milk to calves & labourers	4,249
Total other costs	**7,494**

Labour input	*Ksh/yr*
Hired labour	1,777
Family labour	11,233
Total labour	**13,010**
Total costs	**50,877**
PROFIT	**12,094**

** Capital Recovery Cost*

Nakuru District (survey period 1999)

Number of cows	**2.80**
Forage acreage (acres)	**2.41**
Total acreage (acres)	**7.80**
Milk output (Kg/yr)	**4,478**

Output	*Quantity*	*Unit*	*Prices*	*Ksh/yr*
Bulls	0.16	Head/yr	5,750	896
Castrated adult males	0.08	Head/yr	9,000	701
Immature males	0.00	Head/yr		
Cows	0.31	Head/yr	18,666	5,818
Heifers	0.00	Head/yr		
Male calves	0.08	Head/yr	2,000	156
Female calves	0.00	Head/yr		
Milk sales	3,245.00	Kg/yr	15.19	49,276
Milk to household and relatives	824.00	Kg/yr	15.19	12,506
Milk to calves and labourers	410.00	Kg/yr	15.19	6,220
Total output				**75,572**

Fixed input	*Quantity*	*Initial costs*	*Useful life*	*CRC*
Cows	2.80	17,500	12	5,374
Dairy shed	1.00	15,000	15	1,397
Milk can	1.00	1,200	15	112
Milking bucket	1.00	700	10	88
Panga (machete)	1.00	190	12	21
Wheelbarrow	0.54	2,500	9	184
Handcart	0.00			
Bicycle	0.50	4,000	10	253
Total fixed cost				**7,428**

Intermediate input	*Ksh/yr*
Purchased fodder	791
Cost of own-produced forage	2,408
Concentrates	10,492
Veterinary costs	3,815
Total intermediate	**17,506**

Other cost	*Ksh/yr*
Mortalities	6,039
Milk to calves and labourers	6,220
Total other costs	**12,259**

Labour input	*Ksh/yr*
Hired labour	3,819
Family labour	18,457
Total labour	**22,276**
Total costs	**59,469**
PROFIT	**16,103**

Nyandarua District (survey period 1999)

Number of cows	2.97
Forage acreage (acres)	3.18
Total acreage (acres)	11.40
Milk output (Kg/yr)	4,012

Output	*Quantity*	*Unit*	*Prices*	*Ksh/yr*
Bulls	0.09	Head /yr	20,000	1,714
Castrated adult males	0.00	Head /yr		0
Immature males	0.09	Head /yr	5,500	471
Cows	0.34	Head /yr	12,000	4,114
Heifers	0.34	Head /yr	7,400	2,537
Male calves	0.51	Head /yr	1,014	521
Female calves	0.09	Head /yr	2,000	171
Milk sales	2,273.00	Kg/yr	14.3	32,502
Milk to household and relatives	1,089.00	Kg/yr	14.3	15,572
Milk to calves and labourers	650.00	Kg/yr	14.3	9,302
Total Output				**66,906**

Fixed input	*Quantity*	*Initial costs*	*Useful life*	*CRC*
Cows	2.09	12,900	12	2,958
Dairy shed	1.00	10,000	15	931
Milk can	1.00	1,200	15	112
Milking bucket	1.00	700	10	88
Panga (machete)	1.00	190	12	21
Wheelbarrow	0.42	2,500	9	145
Hand cart	0.03	10,000	10	34
Bicycle	0.50	4,000	10	253
Total Fixed Cost				**4,543**

Intermediate input	*Ksh/yr*
Purchased fodder	445
Cost of own-produced forage	4,773
Concentrates	2,891
Veterinary cost	5,362
Total intermediate	**13,470**

Other cost	*Ksh/yr*
Mortalities	3,949
Milk to calves and labourers	9,302
Total other costs	**13,251**

Labour input	*Ksh/yr*
Hired labour	5,110
Family labour	12,500
Total labour	**17,610**
Total costs	**48,874**
PROFIT	**18,032**

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