# REPORT OF A STUDY ON ASSESSING THE COST OF PRODUCTION STRUCTURES IN DAIRY SYSTEMS IN KENYA

By

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**Executive Summary**

The dairy sub-sector is regarded as a success case within the agriculture sector in Kenya since it supports the poor, creates employment and is commercially oriented. There is potential for growth of the sub-sector both domestically and regionally as Kenya has high per capita milk consumption, and demand within the Eastern and Southern Africa region is estimated at two million tonnes. Thus, this pro-poor and commercially oriented sub-sector has the potential of playing an important role in improving the livelihoods of small-scale farmers. However, realization of the sector's potential has continuously been faced by many challenges as documented in several papers and reports. These include high cost of production, declining land sizes, consumer concerns about milk quality and safety, lack of good quality animal breeds, and poor husbandry and farming practices, among others.

High cost of production is particularly an important challenge and dairy producers have been raising concerns about it. Previous studies on cost of milk production found that in general, dairy farming in Kenya was a profitable enterprise. However, costs differed by production system, with the less intensive systems outperforming the more intensive ones in terms of returns. At the same time, it is observed that producer prices tend to remain relatively sticky even when the production costs are on an upward trend, squeezing producers' profit margins. Recent information on the cost of production and its effect on profitability are not available. Previous studies applied different methodologies which provide differing results that are not easy to compare. In addition, it is not clear how different production systems are affected by the various cost drivers currently. There is thus a need for current information by various stakeholders to guide investment planning and decision making in the sub-sector. This study was undertaken to fill the gap. Its main objective was to assess the cost of milk production in Kenya and identify the major contributing factors.

The study used the "typical/prototype" farm methodology developed by international networks such as the International Farm Comparison Network (IFCN) and Agri benchmark. In this method, a typical farm for a country or a region is identified, reflecting the most dominant/common production structure in a particular region or country. Information is then collected from a panel consisting of farmers practising this typical system and experts mainly through focus group discussions (FGDs). For this study, the first step involved identifying the most important regions and locations for dairy production under zero grazing, semi-zero grazing and open-grazing production systems. A total of 20 counties were identified for study

implementation upon discussions with the Kenya Dairy Board. Further consultations with experts in dairy production helped identify sub-counties and locations. Both qualitative and quantitative data were collected using FGDs following the typical/prototype farm methodology. Data was collected between December 2014 and January 2015 reflecting information for the year 2014.

Analysis was mainly done by production system, although differences within a production system are highlighted at county level. All costs and returns were collected at typical farm level for the year 2014 and then converted to per litre of milk or per lactating cow. Costs are reported mainly as total variable direct costs (TVDC), which is a summation of all variable and direct costs (only explicit costs that vary with level of production); and total costs (TC), which is TVDC plus fixed costs (depreciation of fixed assets) and own factors of production such as family labour and own pasture. In turn, returns are captured mainly as gross margins, which is milk revenue less TVDC, or milk profits, which is milk revenue less TC. Milk revenue is the value of milk that is sold plus milk consumed by the household.

Results show that cost of milk production increases with intensity of production system. In terms of direct variable costs, zero grazers were spending an average of Ksh 19 to produce a litre of milk, while the semi-zero grazers spent Ksh 17.2 and the open grazers, Ksh 10. Consequently, gross margins were highest for open grazers at Ksh 22.8 and lowest for zero grazers at Ksh 12.4 per litre. Typical farmers in all study areas had positive gross margins, meaning that if gross margins are to be taken as the measure of profitability, then milk production is a profitable enterprise for typical farmers in all the counties studied. However, when fixed costs and own factors of production are considered, zero-grazers would barely break even, making a small loss of Ksh 0.6 per litre. Semi-zero grazers made an average profit of Ksh 5.6 per litre of milk produced, and open-grazers made Ksh 7.9 on average.

Feed concentrates formed the largest component of TVDC for the zero-grazers at 41.8% while it was hired labour for the other production systems. When considering TC, family labour was the biggest component of cost across all production systems. Labour in total (family plus hired) contributed more than a third of TC for all production systems, ranging from 38.1% for zero grazers to 51% for the open grazers. Simulations confirm the importance of various cost components to TVDC and returns. For instance, the largest reduction in TVDC for zero-grazers would come from a reduction in cost of feed concentrates. If the cost of feed concentrates would be reduced by 10%, TVDC for zero-grazers would reduce by 4%. For the

other production systems, a reduction in the cost of hired labour would cause the largest reduction in TVDC, at 3% for semi-zero grazers and 4% for open grazers.

These same factors are the most important in increasing returns. For instance, amongst all cost factors, it is the reduction of cost of feed concentrates that would increase gross margins and profits the most, at 7% and 31%, respectively, for zero grazers. However, the effect of an increase in price of milk on returns is much higher than the effect of a reduction in any cost component. For instance, if milk prices increased by 10%, gross margins would increase by 34% for zero grazers, 24% for semi-zero grazers and 16% for open grazers. A 10% increase in prices of milk would more than double milk profits for zero-grazers. It would also increase milk profits by 62% for semi-zero grazers and 41% for open grazers.

With increasing population and shrinking land sizes, dairy production in Kenya will have to become more and more intensive. However, since our results show that this shift comes with higher costs and lower returns, policy actions are needed so as to address this and improve returns for the more intensive systems. The main cost drivers for the intensive systems are feed concentrates and labour. Measures of reducing high cost of animal feeds, including relooking at tax regimes and own feed formulation, need to be explored. In addition, small-scale labour-saving technologies should be explored to address this.

Additionally, this study has shown that an increase in producer price is a more important driver of dairy returns compared to cost reduction. Typical farmers selling to traders and consumers received better milk prices than those selling to processors and dairy cooperatives, and consequently registered better returns on average. There is a need to look at how producer prices can be improved considering that most farmers are moving to collective marketing either through cooperative societies or directly to processors. Transaction costs such as cooperative management fees need to be looked at. In addition, while the cost of processing is not known, it worth noting that producer prices paid by processors are on average just a third of the prices of pasteurized milk.

# 1. Introduction

## 1.1 Background

The dairy sub-sector is regarded as a success case within the agriculture sector in Kenya. It supports the poor, and according to statistics, smallholders who own one to three cows contribute about 80% of total milk production. In addition, the sub-sector creates employment directly due to most of the systems being labour intensive, or indirectly through linkages with the informal sector. It is estimated that the sub-sector provides employment to two million people either directly or indirectly. There are no updated statistics on the number of smallholder dairy farmers but they are estimated to be more than two million with more than five million animals (Staal et al., 2008).

The commercial orientation of the sub-sector further strengthens the notion of a successful model. There is potential for growth of the sub-sector domestically and regionally. Kenya is reported to have the highest per capita milk consumption in East Africa at 145 litres per person per year (SDP, 2005). In addition, Kenya can easily tap into the demand within the Eastern and Southern Africa region, estimated at two million tonnes (SNV, 2013). All these factors point to a pro-poor commercially-oriented sub-sector that can play a big role in improving the livelihoods of small-scale farmers (Leksmono et al. 2006; Ngigi, 2005).

However, realization of the sector's potential has continuously been faced by many challenges including increasing cost of inputs, declining land sizes, consumer concerns about milk quality and safety, and unfair trade practices, which have been cited as threats to the growth of the industry in Kenya. Several papers and reports have outlined problems facing small-scale dairy farmers in Kenya. These include high cost of production, low productivity, seasonality in production, lack of good quality animal breeds, poor husbandry and farming practices, poor access to breeding, animal health and credit services, and high cost of artificial insemination services (SNV, 2013; Wambugu et al., 2011; Technoserve, 2008). In terms of low productivity, Wambugu et al (2011) found that on average, farmers received 3.67 litres per cow per day in 2010. This is a pale comparison to productivity figures for developed dairy sectors such as Denmark and Australia which are producing well above 20 litres per cow per day (Technoserve, 2011).

High cost of production is particularly an important challenge and dairy producers have been raising concerns about it. Cost of production had been estimated previously for Kenya in 2003 when Staal et al. (2003) found that dairy farming in Kenya was a profitable enterprise. Wambugu et al. (2011) estimated the cost of production in 2010 and found that purchase of concentrates was the largest share of variable costs. These authors further found that costs differed by production system, with the less intensive systems outperforming the more intensive ones in terms of economic performance. There are three main systems of dairy production in Kenya. These are intensive zero-grazing, semi-zero (mixed) and open grazing systems. Wambugu et al. (2011) found that non-zero grazing systems were the most economically viable form of dairy production and that the gross margins for dairy farmers were lower among zero-grazers. This was because they incurred higher variable costs, translating to Ksh 12/litre as compared to Ksh 9/litre for non-zero grazers. In one of the study areas, the intensive system of production returned negative gross margins. Despite the high costs of production, observations show that producer prices tend to remain relatively sticky even when production costs are on an upward trend. This has the effect of squeezing producers' profit margins and reducing incentives for dairy production.

### 1.2 Rationale for this study

Recent information on the cost of production and its effect on profitability are not available. Previous studies on economic performance of the dairy sector applied different methodologies which provide differing results that are not easy to compare. Although it has been argued that feeds contribute about 80% of the costs of production (Wambugu et al. 2011), it is not clear how different production systems are affected by the various cost drivers currently. Different parts of Kenya are dominated by different production systems which have an important bearing on the costs of production, hence there is need to compare the efficiency and competitiveness of the different systems.

In addition to costs, milk prices are important determinants of the economic performance of the dairy sub-sector. The view of most dairy farmers is that they receive low prices from processors which are not sufficient to cover their costs of production. Considering these factors, there is demand for current information by various stakeholders to guide investment planning and decision making in the sub-sector.

### 1.3 Research Objectives

The objective of this study was to assess the cost of milk production in Kenya and identify the major contributing factors. The specific objectives were to:

a) Estimate the costs of milk production and profitability in Kenya across different production systems and scales
b) Identify the key factors that influence the cost of production and their relative importance, and
c) Identify key intervention areas needed to reduce the high cost of production and ensure competitiveness of the sub-sector.

## 2. Methodology

### 2.1 The "Typical/Prototype farm approach"

Several methods are available in literature for estimating cost of production for agricultural enterprises. A relatively new methodology is based on "typical" or "representative" or "prototype" farms (Garcia et al., 2006; Langrell et al., 2012; Zimmer, 2005). This is the method followed by some international networks such as the International Farm Comparison Network (IFCN) (for dairy sector) and Agri benchmark (for crop sector). These are world-wide associations composed of agricultural researchers, farmers and other experts. In this method, a typical farm for a country or a region is identified by a team composed of experts and producers. The idea is to reflect the most dominant/common production structure in a particular region or country (Garcia et al., 2006). After this identification, information is collected for typical farms mainly using focus group discussions (FGDs) or case studies.

One of the main advantages of the "typical" farm approach is its international standardization which can allow comparison (bench marking) of costs of production for different regions, countries and over time. The methodology is also inexpensive in comparison to other methods such as representative household surveys. Using this methodology, a typical farm for a region is identified based on main characteristics such as the production system, scale of production and management system/labour organization. This study used the typical farm approach.

## 2.2 Study areas

To gain representativeness using the typical farms approach, typical farms are usually established in major production areas, which are of highest importance for the national/regional output of the product in question. In this study, the first step involved identifying the most important counties for dairy production in the country under three production systems: zero grazing, semi-zero grazing and open/free grazing. Discussions between KDB and Tegemeo Institute led to the selection of 20 counties for study implementation. This selection considered the importance of counties to national milk production, as wells as the need to have the three production systems and various production scales represented in the study.

**Table 1. Identified areas for study implementation**

| County | Sub-County | Division | Location | Production System | Scale |
|---|---|---|---|---|---|
| Taita Taveta | Taita | Wundanyi | Wundanyi | Zero | Small |
| Meru | Imenti North | Miringa Mieru West | Nthibiri | Zero | Small |
| Nyeri | Mukuruwe-Ini | Mukuruwe-Ini Central | Muhito | Zero | Small |
| Muranga | Kangema | Muguru | Muguru | Zero | Small |
| Embu | Embu North | Manyatta | Gandori East | Zero | Small |
| Kiambu | Githunguri | Githunguri | Githunguri | Zero | Medium |
| Nakuru | Bahati | Bahati | Kiamaina | Semi-Zero | Small |
| Kisii | Kitutu Chache South | Mosocho | Nyakoe | Semi-Zero | Small |
| Kakamega | Lurambi | Lurambi | Murumba | Semi-Zero | Small |
| Bomet | Bomet Central | Bomet Central | Ndaraweta | Semi-Zero | Small |
| Uasin Gishu | Ainabkoi | Ainabkoi | Ainabkoi | Semi-Zero | Small |
| Nyandarua | Olkalou | Kiambaga | Muhito | Semi-Zero | Medium |
| Bungoma | Kanduyi | Kanduyi | Township | Semi-Zero | Medium |
| Nandi | Chesumei | Kosirai | Mutwot | Semi-Zero | Medium |
| Trans Nzoia | Trans Nzoia East | Cherangany | Cherangany | Semi-Zero | Medium |
| Elgeyo Marakwet | Keiyo South | Metkei | Kamwosor | Semi-Zero | Medium |
| Machakos | Machakos | Central | Township | Semi-Zero | Medium |
| Migori | Suna West | Suba West | Suna South | Open | Medium |
| Baringo | Koibatek | Eldama Ravine | Ravine | Open | Medium |
| Narok | Transmara West | Kilgoris | Oloibor Soito | Open | Large |

*Notes: In a few cases the production system or scale differed from what was hypothesized*

The most important sub-counties in milk production in each of the identified counties were then identified with the help of dairy experts consisting of Ministry of Agriculture, Livestock

and Fisheries (MOAL&F) officials at county level and KDB regional managers. This consultation, which was done through telephone calls, also identified the dominant production systems and scales practised by farmers in each selected location. Table 1 shows the identified areas for study implementation.

### 2.3 Data collection

Data for this study was collected using FGDs following the typical/prototype farm methodology. Having identified the study areas (sub-counties and locations), the study teams travelled to these selected locations. The first step undertaken by the team was validation of information collected from dairy experts earlier through phone calls. This was to ensure that the identified locations were indeed the most important for dairy production within the county (and sub-county). The study teams also verified the production system and scale practised by the dominant systems, with adjustments being done where there were differences.

Prototype farms were then created for the purpose of undertaking FGDs. To create the prototype dairy farms, a panel group of participants comprising of farmers in a selected area, and experts from the area who are knowledgeable in dairy production was used. The farmers in the panel were typical farmers in the targeted county, meaning that they were practising the most dominant production system and scale in that county. The experts included agricultural extension practitioners and farmer group leaders. The role of the experts in the panel was mainly to verify and validate the information collected from the farmers during the FGDs. Information provided by farmers was, therefore, checked and validated to ensure that it reflected the typical situation for the selected area. The data were further scrutinized at the analysis level and those that looked inconsistent were subjected to a process of data confirmation with the panel of experts.

Both qualitative and quantitative data were collected in this study. In each identified study area, a panel consisted of 10-15 participants, with a third of these being female. A structured questionnaire was used to collect information from the established panel in an FGD set-up. The questionnaire contained questions that elicited responses on the characteristics of the typical farms such as production levels, costs incurred in production, milk consumption and sales, and use of by-products. Data was collected in December 2014 and January 2015 reflecting information for the year 2014.

## 2.4 Data analysis

### 2.4.1 Level of analysis

Analysis was mainly done by production system despite the existence of different scales within a production system. This is primarily because some scales were only represented by only one county. In such cases, the information would not give the average picture but the situation of just that one county. For instance, among the six counties where typical farmers practise zero-grazing, it is only in Kiambu where there were farmers who could be categorized as medium-scale, with all the others falling under small-scale. Likewise, for the open grazers, Narok was in the "large" scale by itself, while Migori and Baringo were classified as medium-scale. It is only within the semi-zero grazing system that we had a good number of counties with small and medium scale producers. Considering this, analysis was mainly done at the production system level. In addition, differences within a production system were highlighted at county level, although averages for the small and medium scales within the semi-zero grazing system are also presented.

### 2.4.2 Computing cost and returns

All costs and returns were collected at typical farm level for the year 2014 using the typical farm methodology. These were then converted to per litre of milk or per lactating cow.

### 2.4.3 Definition of costs and returns

**Total variable direct costs (TVDC)**: This is a summation of all variable and direct costs. This includes only explicit costs that are variable. Indirect costs (factors not paid for directly) such as own fodder were not included in this category even if they vary with level of production.

**Total costs (TC)**: This is TVDC plus fixed costs (depreciation of fixed assets) and own factors of production such as family labour and own pasture. Herd depreciation was not considered in this analysis. Depreciation of fixed assets was calculated using the straight line method as follows:

Depreciation per annum = (Cost-residual value)/useful life

where *cost* is the initial acquisition or construction costs related to the asset, *residual value* is the estimated proceeds expected from the disposal of an asset at the end of its useful life, and *useful life* is the estimated time period that the asset is expected to be used starting from the date it is available for use up to the date of its disposal.

**Milk revenue**: This is the value of milk that is sold plus milk consumed by the household. Milk fed to calves was not considered as part of revenue; for many counties where semi-zero and open grazing are practised, determining this would be difficult since the calves are suckled directly. Milk given to workers was included as part of hired labour where applicable.

**Other farm revenue:** This includes sales of livestock and manure, manure used at own farm and bull services.

Returns were categorized into three as follows:

**Gross margin** is milk revenue less TVDC. This can also be referred to as accounting returns.

**Profit from milk production only** (referred hereafter as milk profit) is milk revenue less TC. This can also be referred to as economic returns.

**Profit from whole dairy enterprise** (referred hereafter as whole enterprise profit) takes into account other farm revenues as mentioned above.

Since the main output from a dairy enterprise is milk, gross margins and milk profits were the main units used to describe returns in this analysis.

## 3. Results

### 3.1 Description of prototype farms by production systems and county

***Zero grazing system***

The zero grazing system was dominant in six out of the 20 counties visited. This means that the most dominant system of production (with the highest output) is zero-grazing in these six counties, which include Taita Taveta, Meru, Nyeri, Murang'a, Embu and Kiambu. Table 2 shows the characteristics of typical zero-grazers.

The typical zero-grazer owned 3.7 cows out of which 1.8 were lactating. Only typical farmers in Kiambu can be described as medium-scale since they were keeping more than five cows. Under the zero-grazing production system, cows are kept in a zero-grazing unit where most of the activities such as feeding and milking are all carried out. The most dominant breed kept was Fresian crossbreed, although in Embu and Kiambu counties Fresian pure breed was the most common. Average productivity for the year, which includes high and low production months, was 9.1 litres per cow per day. There were differences, however, with Kiambu registering the highest productivity at 12.3 litres and Taita Taveta the lowest at 7 litres per cow per day.

**Table 2. Characteristics of typical farmers practising zero-grazing**

| County | T/Taveta | Meru | Nyeri | Muranga | Embu | Kiambu | Average |
|---|---|---|---|---|---|---|---|
| Scale | Small | Small | Small | Small | Small | Medium | - - |
| Total cows | 2 | 2 | 3 | 4 | 5 | 6 | 3.7 |
| Lactating cows | 1 | 1 | 2 | 2 | 2 | 3 | 1.8 |
| Breed | Fresian cross | Fresian cross | Fresian cross | Fresian cross | Fresian pure | Fresian pure | - - |
| Total fresh milk produced (Liters/farm/year) | 2,505 | 3,270 | 6,900 | 6,300 | 5,940 | 13,230 | 6,358 |
| Average productivity (Liters/cow/day) | 7 | 9.1 | 9.6 | 8.8 | 8.3 | 12.3 | 9.1 |
| Value of milk produced (Ksh/farm/year) | 96,600 | 114,450 | 199,200 | 180,600 | 192,600 | 486,945 | 211,733 |
| Main buyer of milk | Traders | Traders | Dairy coop | Dairy coop | Traders | Dairy coop | - - |
| Average price of milk in 2014 (Ksh/liter) | 38.6 | 35 | 28.9 | 28.7 | 32.4 | 36.8 | 33.4 |

Typical farmers in half of the counties were selling milk mainly to traders, while the others sold to dairy cooperatives. The average milk price for the year 2014 was Ksh 33.4 per litre. In

general, those selling to traders received higher prices than those selling to dairy cooperatives. For Kiambu County, however, the price of milk for the dairy cooperative was comparable to best prices received by other counties that were selling mainly to traders.

***Semi-zero grazing system***

Semi-zero grazing was the most dominant production system in eleven of the twenty counties included in the study. Typical farmers in five of these can be considered small-scale since they kept a maximum of five cows (Table 3). These are Nakuru, Kisii, Kakamega, Bomet, and Uasin Gishu. Hence, the most dominant system of production in these counties was small-scale semi-zero grazing.

**Table 3. Characteristics of typical farmers practising semi-zero grazing, small-scale**

| County | Nakuru | Kisii | Kakamega | Bomet | U/Gishu | Average |
|---|---|---|---|---|---|---|
| Scale | Small | Small | Small | Small | Small | - - |
| Total cows | 4 | 4 | 4 | 5 | 5 | 4 |
| Lactating cows | 2 | 2 | 2 | 2 | 3 | 2 |
| Breed | Fresian cross | Fresian cross | Ayrshire cross | Fresian cross | Fresian cross | - - |
| Total fresh milk produced (Liters/farm/year) | 7,200 | 4,440 | 5,280 | 4,500 | 6,990 | 5,556 |
| Average productivity (Liters/cow/day) | 10.0 | 6.2 | 7.3 | 6.3 | 6.5 | 7 |
| Value of milk produced (Liters/farm/year) | 216,000 | 222,000 | 316,800 | 137,070 | 198,960 | 214,638 |
| Main buyer of milk | Traders | Consumers | Consumers | Processor | Dairy Coop | - - |
| Average price of milk (Ksh/liter) | 30.0 | 50.0 | 60.0 | 30.5 | 28.5 | 39.8 |

The typical small-scale semi-zero grazer owned four cows with two of them lactating (Table 3). For all these counties, Fresian crossbreed was the most common breed. On average, typical farmers in these counties recorded seven litres of milk per cow per day. Productivity was highest in Nakuru county (10 litres) and lowest in Kisii (6.2 litres). Typical farmers in Kisii and Kakamega sold their milk predominantly directly to consumers and they received the highest average price of Ksh 50 and 60 per litre, respectively. The lowest milk price was received by typical farmers in Uasin Gishu (Ksh 28.5) who sold their milk to a dairy cooperative.

Typical farmers in the other six counties that were practising semi-zero grazing are considered medium scale as they kept more than five cows. These counties are Nyandarua, Bungoma, Nandi, Trans Nzoia, Elgeyo Marakwet and Machakos (Table 4). The average number of cows kept was eight, with three of them lactating.

**Table 4. Characteristics of typical farmers practising semi-zero grazing, medium-scale**

| County | Nyandarua | Bungoma | Nandi | T/Nzoia | E/Marakwet | Machakos | Average |
|---|---|---|---|---|---|---|---|
| Scale | Medium | Medium | Medium | Medium | Medium | Medium | - - |
| Total cows | 6 | 6 | 7 | 8 | 10 | 10 | 8 |
| Lactating cows | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Breed | Fresian cross | Fresian cross | Fresian cross | Ayrshire cross | Ayrshire cross | Fresian cross | - - |
| Total fresh milk produced (Liters/farm/year) | 6,075 | 8,280 | 5,760 | 6,090 | 5,970 | 9,900 | 7,013 |
| Average productivity (Liters/cow/day) | 5.6 | 7.7 | 5.3 | 5.6 | 5.5 | 9.2 | 6 |
| Value of milk produced (Liters/farm/year) | 167,063 | 413,400 | 174,720 | 187,200 | 175,350 | 343,080 | 243,469 |
| Main buyer | Dairy coop | Consumers | Dairy Coop | Traders | Dairy Coop | Dairy coop | - - |
| Average Price (Ksh/liter) | 27.5 | 49.9 | 30.3 | 30.7 | 29.4 | 34.7 | 34 |

Fresian cross was the most dominant breed, although for two of these counties (Trans Nzoia and Elgeyo Marakwet), the common breed was Ayrshire crossbreed. The average productivity was 6 litres per cow per day, being highest in Machakos at 9.2 litres and lowest in Nandi at 5.3 litres. The highest milk price was received by typical farmers in Bongoma (Ksh 50) who sold their milk mainly directly to consumers.

***Open grazing system***

The typical open-grazing dairy farm was found in only three Counties and had an average of 22 cows with 7 of them lactating (Table 5). Average milk productivity was low, at an average of 3.5 litres per cow per day. Productivity was highest in Baringo at 5.6 litres where the main breed was Fresian cross, and lowest in Migori (1.9 litres) where Zebu was the most common breed. The highest milk price was received by typical farmers in Migori (Ksh 40 per litre) who sold their milk primarily to traders.

**Table 5. Characteristics of typical farmers practising open-grazing**

| County | Migori | Baringo | Narok | Average |
|---|---|---|---|---|
| Scale | Medium | Medium | Large | - - |
| Total cows | 6 | 10 | 50 | 22 |
| Lactating cows | 2 | 4 | 15 | 7 |
| Breed | Zebu | Fresian cross | Sahiwal | - - |
| Total fresh milk produced (Liters/farm/year) | 1,350 | 8,040 | 16,830 | 8,740 |
| Average productivity (Liters/cow/day) | 1.9 | 5.6 | 3.1 | 3.5 |
| Value of milk produced (Liters/farm/year) | 54,000 | 224,040 | 514,440 | 264,160 |
| Main buyer | Traders | Dairy Coop | Processor | - - |
| Average Price (Ksh/liter) | 40 | 27.9 | 30.6 | 32.8 |

### 3.2 Costs and returns per litre of milk produced

#### 3.2.1 Per litre costs and returns by production system

Results indicate that costs of milk production were highest for farmers undertaking zero-grazing and lowest for those practising the open-grazing production system (Table 6). These findings are consistent whether one looks at only TVDC or TC. When considering only TVDC, the zero grazers spent Ksh 19 to produce a litre of milk, closely followed by the semi-zero grazers at Ksh 17.2. The open grazers spent Ksh 10 per litre of milk produced, which is about 47% lower than those practising zero-grazing. Consequently, the gross margins per litre of milk produced were lowest for zero-grazers at Ksh 12.4 and highest for those undertaking open grazing (Ksh 22.8).

When fixed and opportunity costs were factored in, the TC of producing a litre of milk increased to Ksh 32, 28.5 and 24.8 for zero grazers, semi-zero grazers and open grazers, respectively. The total cost is slightly higher than the revenue per litre for zero grazers, meaning that they were almost breaking even, making a loss of Ksh 0.6 in milk production while the other systems returned a profit. It is only when other revenues from a dairy enterprise were considered (such as sale of livestock and manure) that farmers in the zero-grazing production system recorded a profit.

**Table 6. Costs and returns in Ksh per litre of milk by production system**

| Production system | Zero | Semi-Zero | Open |
|---|---|---|---|
| Counties | T/Taveta, Meru, Nyeri, Muranga, Embu, Kiambu | Nakuru, Kisii, Kakamega, Bomet, U/Gishu, Nyandarua, Bungoma, Nandi, T/Nzoia, Marakwet, Machakos | Migori, Baringo, Narok |
| Revenue from milk (sold + consumed) | 31.4 | 34.1 | 32.7 |
| Purchased fodder/pasture | 1.8 | 1.0 | 0.0 |
| Feed concentrates | 6.9 | 4.6 | 0.7 |
| Mineral salts | 1.2 | 1.4 | 0.8 |
| Water (purchased) | 2.2 | 0.2 | 0.1 |
| Health and breeding costs | 1.6 | 2.3 | 2.1 |
| Milking jelly | 0.3 | 0.2 | 0.1 |
| Hired labour | 4.5 | 6.7 | 4.9 |
| Repairs on fixed assets | 0.2 | 0.6 | 0.8 |
| Other direct costs (e.g. electricity, fuel ) | 0.2 | 0.2 | 0.5 |
| Total variable and directs costs (TVDC) | 19.0 | 17.2 | 10.0 |
| Gross margin (Revenue - TVDC) | 12.4 | 16.9 | 22.8 |
| Depreciation (fixed assets) | 0.3 | 0.4 | 0.1 |
| Own fodder/pasture | 5.2 | 4.8 | 6.5 |
| Family labour | 7.6 | 6.1 | 8.2 |
| Total costs (TC = TVDC + depr. + opp. cost) | 32.0 | 28.5 | 24.8 |
| Milk profits (Revenue - TC) | -0.60 | 5.6 | 7.9 |
| Other revenue (sale of livestock, manure, bull serv.) | 6.4 | 3.6 | 22.9 |
| Whole enterprise profit | 5.8 | 9.1 | 30.8 |
| Gross margin as a proportion of TVDC (%) | 65.3 | 98.3 | 228.0 |
| Gross margin rate as a proportion of revenue (%) | 39.5 | 49.6 | 69.7 |
| Milk profits as a proportion of TVDC (%) | -3.2 | 32.6 | 79.0 |
| Milk profits as a proportion of revenue (%) | -1.9 | 16.4 | 24.2 |

### 3.2.2 Per litre costs and returns for individual counties

#### a) Zero grazers

Among zero-grazers, TVDC per litre of milk produced were highest for farmers in Meru at Ksh 30.4 followed by Embu at Ksh 22.5 (Table 7). For these two counties, the high cost was mainly as a result of the use of hired labour in addition to substantial usage of feed concentrates. Farmers in Taita Taveta had the third highest TVDC per litre at Ksh 21.7. These high costs were mainly due to cost associated with purchase of water. The TVDC were also high for Kiambu (Ksh 20.6) due to high use of feed concentrates per litre of milk produced. Despite

using at least Ksh 5 per litre of milk on feed concentrates, the TVDC for Nyeri and Muranga were lowest (Ksh 8.7 and Ksh 10, respectively). Farmers in these two counties used very little of hired labour and they also did not use purchased fodder or pasture.

**Table 7. Summary of costs and returns in Ksh per litre of milk for zero-grazers**

| County | T/Taveta | Meru | Nyeri | Muranga | Embu | Kiambu |
|---|---|---|---|---|---|---|
| Revenue from milk (sold + consumed) | 34.6 | 35 | 26.7 | 27 | 29 | 35.8 |
| Total variable and directs costs (TVDC) | 21.7 | 30.4 | 8.7 | 10 | 22.5 | 20.6 |
| Gross margin (Revenue - TVDC) | 12.9 | 4.6 | 18.1 | 17 | 6.5 | 15.2 |
| Total costs (TC = TVDC + depr. + opp. cost) | 43.5 | 38.5 | 23.5 | 26.1 | 32.5 | 27.9 |
| Milk profits (Revenue - TC) | -8.9 | -3.5 | 3.2 | 0.9 | -3.5 | 7.9 |
| Gross margin as a proportion of TVDC (%) | 59.4 | 15.1 | 208.0 | 170.0 | 28.9 | 73.8 |
| Gross margin rate as a proportion of revenue (%) | 37.3 | 13.1 | 67.8 | 63.0 | 22.4 | 42.5 |
| Milk profits as a proportion of TVDC (%) | -41.0 | -11.5 | 36.8 | 9.0 | -15.6 | 38.3 |
| Milk profits as a proportion of revenue (%) | -25.7 | -10.0 | 12.0 | 3.3 | -12.1 | 22.1 |

*Note: full results are shown in Table A1 in the appendix*

Revenue from milk was mainly determined by the average net price. As shown in Table 2, average milk prices were highest in Taita Taveta at Ksh 38.6 followed by Kiambu at Ksh 36.8 per litre. Consequently, milk revenue was highest in these counties. The prices were lowest in Nyeri and Muranga, at just below Ksh 29. Despite these differences, all the zero grazers returned a positive gross margin. Gross margin per litre was highest in Nyeri and Muranga (between Ksh 17 and 18) mainly due to low TVDC in these counties. Despite the high TVDC for Kiambu (Ksh 20.6) and Taita Taveta (Ksh 21.7), farmers in these counties recorded gross margins of Ksh 15.2 and 12.9, respectively, since they received the highest milk prices among the zero-grazers. Meru has the lowest gross margin (Ksh 4.6) despite high net milk prices due to the high TVDC. Upon factoring fixed costs and own factors of production, the total cost of producing a litre of milk for the zero grazers ranged from Ksh 23.5 in Nyeri to Ksh 43.5 in Taita Taveta. Milk profits were highest in Kiambu at Ksh 7.9 followed by Nyeri at Ksh 3.2 and Muranga at Ksh 0.9. Farmers in Taita Taveta, Meru and Embu counties recorded economic losses from milk production.

**b) Semi-zero grazers**

For the small-scale semi-zero grazers, TVDC was very high for Kakamega at Ksh 36.2 per litre compared to the other counties (Table 8). Producers in this county spent most on feed concentrates: Ksh 8.6 for every litre of milk produced compared to the average of Ksh 6 for this category (Table A2). They also spent a total of Ksh 18.6 per litre on hired labour, unlike the others in this category who mainly depended on family labour. The TVDC was also high for Uasin Gishu as farmers there spent a considerable amount on hired labour (Ksh 12).

**Table 8. Summary of costs and returns in Ksh per litre of milk for semi-zero grazers, small scale**

| County | Nakuru | Kisii | Kakamega | Bomet | U/Gishu | Average |
|---|---|---|---|---|---|---|
| Revenue from milk (sold + consumed) (Ksh/litre) | 25.5 | 44.9 | 55.9 | 30.5 | 24.4 | 36.2 |
| Total variable and directs costs (TVDC) | 13.2 | 14.8 | 36.2 | 12.4 | 20.5 | 19.4 |
| Gross margin (Revenue - TVDC) | 12.3 | 30.1 | 19.7 | 18.1 | 4 | 16.8 |
| Milk profits (Revenue - TC) | -0.1 | 18.6 | 11.7 | 5.2 | -3.3 | 6.4 |
| Gross margin as a proportion of TVDC (%) | 93.2 | 203.4 | 54.4 | 146 | 19.5 | 103.3 |
| Gross margin rate as a proportion of revenue (%) | 48.2 | 67 | 35.2 | 59.3 | 16.4 | 45.3 |
| Milk profits as a proportion of TVDC (%) | -0.8 | 125.7 | 32.3 | 41.9 | -16.1 | 36.6 |
| Milk profits as a proportion of revenue (%) | -0.4 | 41.4 | 20.9 | 17 | -13.5 | 13.1 |

*Note: full results are shown in Table A2 in the appendix*

Gross margins were highest in Kisii as a result of high milk prices and low cost of production. Despite Kakamega registering the highest TVDC, it had the second highest gross margin because of a very high average milk price of Ksh 60 per litre. Due to low milk prices in Nakuru, farmers just managed to break even, making a small loss of Ksh 0.1 per litre. On the other hand, producers in Uasin Gishu made a larger loss (Ksh 3.3 per litre) mainly because of very low milk prices and high costs of production. Farmers in the other counties recorded a milk profit which was highest in Kisii.

For the semi-zero grazing producers falling within medium-scale, TVDC were highest in Trans Nzoia at Ksh 21.9 per litre followed by Machakos at Ksh 18.7 (Table 9). These two counties recorded a high amount on hired labour (higher for Trans Nzoia). Gross margin was highest for Nandi (Ksh 22.5) as this county has the least TVDC within this category.

**Table 9. Summary of costs and returns in Ksh per litre of milk for semi-zero grazers, medium scale**

| County | Nyandarua | Bungoma | Nandi | T/Nzoia | E/ Marakwet | Machakos | Average |
|---|---|---|---|---|---|---|---|
| Revenue from milk (sold + consumed) (Ksh/liter) | 23.4 | 47 | 30.3 | 30.7 | 29.4 | 32.7 | 32 |
| Total variable and directs costs (TVDC) | 10.3 | 16.1 | 7.8 | 21.9 | 16.9 | 18.7 | 15 |
| Gross margin (Revenue - TVDC) | 13.2 | 31 | 22.5 | 8.9 | 12.4 | 13.9 | 17 |
| Total costs (TC = TVDC + depr. + opp. cost) | 23.7 | 26.4 | 26.9 | 28.5 | 24 | 34.8 | 27 |
| Milk profits (Revenue - TC) | -0.3 | 20.6 | 3.4 | 2.2 | 5.4 | -2.1 | 5 |
| Gross margin as a proportion of TVDC (%) | 128.2 | 192.5 | 288.5 | 40.6 | 73.4 | 74.3 | 133 |
| Gross margin as a proportion of revenue (%) | 56.4 | 66 | 74.3 | 29 | 42.2 | 42.5 | 52 |
| Milk profits as a proportion of TVDC (%) | -2.9 | 128 | 43.6 | 10 | 32 | -11.2 | 33 |
| Milk profits as a proportion of revenue (%) | -1.3 | 43.8 | 11.2 | 7.2 | 18.4 | -6.4 | 12 |

*Note: full results are shown in Table A3 in the appendix*

When small scale semi-zero grazers were compared to medium scale semi-zero grazers, we find that TVDC were higher for the small-scale category. For every litre of milk produced, Ksh 19.4 was spent on TVDC compared to Ksh 15 for the medium scale. The former, however, enjoyed better average prices resulting in slightly higher milk profits.

### c) Open grazers

The TVDC varied quite widely for open grazers, ranging from Ksh 15.9 in Baringo to a low of Ksh 4.7 in Migori (Table 10). Consequently, gross margins per litre were highest in Migori (Ksh 35.3) because of the low costs and also due to higher milk prices received. The ratio of gross margin to TVDC was highest in Migori than any other county, at 751%. However, the TC was highest in Migori, which was mainly due to high labour costs. As a result, profits from milk production were almost similar in the three counties despite producers in Migori enjoying better milk prices than the rest.

**Table 10. Summary of costs and returns in Ksh per litre of milk for open grazers**

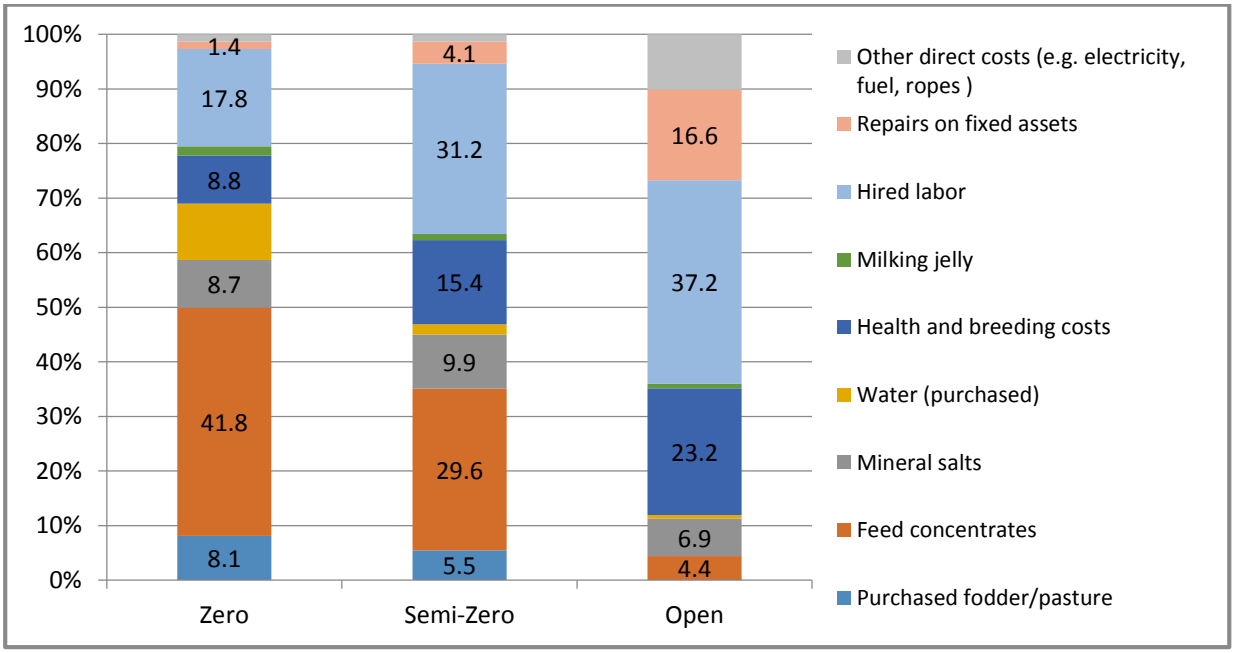
| County | Migori | Baringo | Narok | Average |
|---|---|---|---|---|
| Revenue from milk (sold + consumed) (Ksh/liter) | 40 | 27.9 | 30.4 | 32.8 |
| Total variable and directs costs (TVDC) | 4.7 | 15.9 | 9.4 | 10 |
| Gross margin (Revenue - TVDC) | 35.3 | 12 | 21 | 22.8 |
| Total costs (TC = TVDC + depr. + opp. cost) | 31.6 | 20 | 22.9 | 24.8 |
| Milk profits (Revenue - TC) | 8.4 | 7.8 | 7.5 | 7.9 |
| Gross margin as a proportion of TVDC (%) | 751.1 | 75.5 | 223.4 | 350 |
| Gross margin as a proportion of revenue (%) | 88.3 | 43 | 69.1 | 66.8 |
| Milk profits as a proportion of TVDC (%) | 178.7 | 49.1 | 79.8 | 102.5 |
| Milk profits as a proportion of revenue (%) | 21 | 28 | 24.7 | 24.5 |

*Note: full results are shown in Table A4 in the appendix*

### 3.3 Contribution of different factors to total cost of milk production

The largest component of TVDC for the zero grazers was feed concentrates, accounting for 41.8 % of the total cost (Figure 1).

**Figure 1. Share of different components to total variable direct costs (TVDC)**




In fact, feed concentrates formed the largest component of TVDC in all counties practising zero grazing apart from Taita Taveta and Meru, where the largest contibutors to TVDC were water (53%) and hired labour (60%), respectively (see Table A5 in the appendix). Proportion of feed concentrates to TVDC was highest in Kiambu at 66% followed by Nyeri (58%) and Muranga (56%). Hired labour was the second largest component of TVDC for zero-grazers at

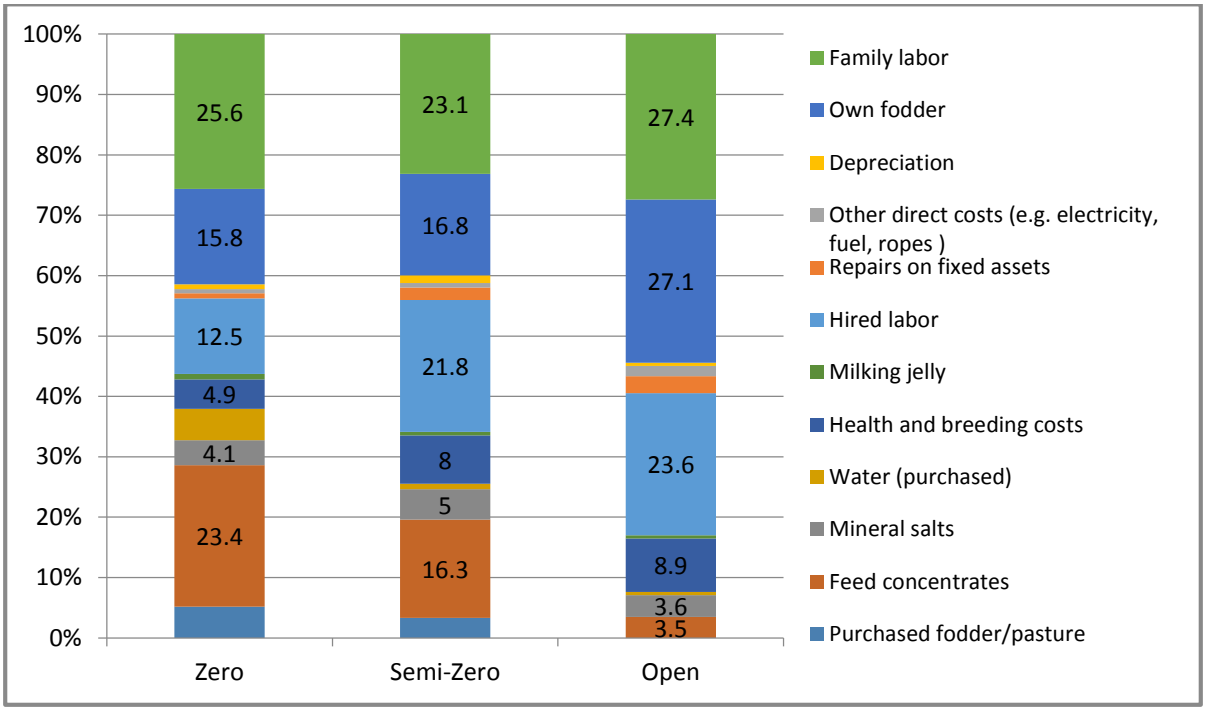
17.8%. However, typical zero-grazers in Taita Taveta and Nyeri counties did not incur hired labour and producers in Kiambu only spent a little on hired labour (4%).

However, for farmers practising semi-zero grazing, hired labour was the largest component of TVDC at 31.2% followed by feed concentrates at 29.6% (Figure 1). There were, however, differences among the semi-zero grazers in terms of the largest contributor to TVDC (Table A5). In Bungoma, Machakos, Kakamega, Uasin Gishu, Trans Nzoia, and Elgeyo Marakwet, hired labour contributed at least 45% of the TVDC. For most of the other semi-zero grazers (in Bomet, Kisii, Nyandarua, and Nakuru counties), feed concentrates formed the largest component of TVDC (at least 41%). Health and breeding formed a substantial amount of TVDC for farmers in Nyandarua and Nandi (at least 30%).

The largest component of TVDC for open grazers was hired labour at 37.2% followed by breeding and health costs (23.2%). For Migori, however, the largest component was repairs on fixed assets (47%) (Table A5). Typical open grazing farmers in Narok and Migori did not buy feed concentrates. For Baringo, however, feed concentrates accounted for 13.2% of TVDC.

Family labour was the largest component of TC for all production systems (Figure 2). Even for the zero grazers, the share of family labour to total cost of producing a litre of milk (25.6%) was higher than the proportion that was spent on feed concentrates (23.4%). It was only in Kiambu and Embu that feed concentrates still formed the largest component of total cost at 48.6% and 28.5%, respectively. Also for Meru, there was no family labour used but hired labour contributed the largest component to total cost at 47.7%. The proportion of family labour to TC was 23.1% for the semi-zero grazers and 27.4% for those practising open grazing. The second largest contributor to total cost was hired labour at 21.8% for the semi-zero grazers and own fodder (27.1%) for the open grazers. Total labour (family plus hired) formed more than a third of TC for all production systems, ranging from 38.1% for the zero grazers to 51% for the open grazers.

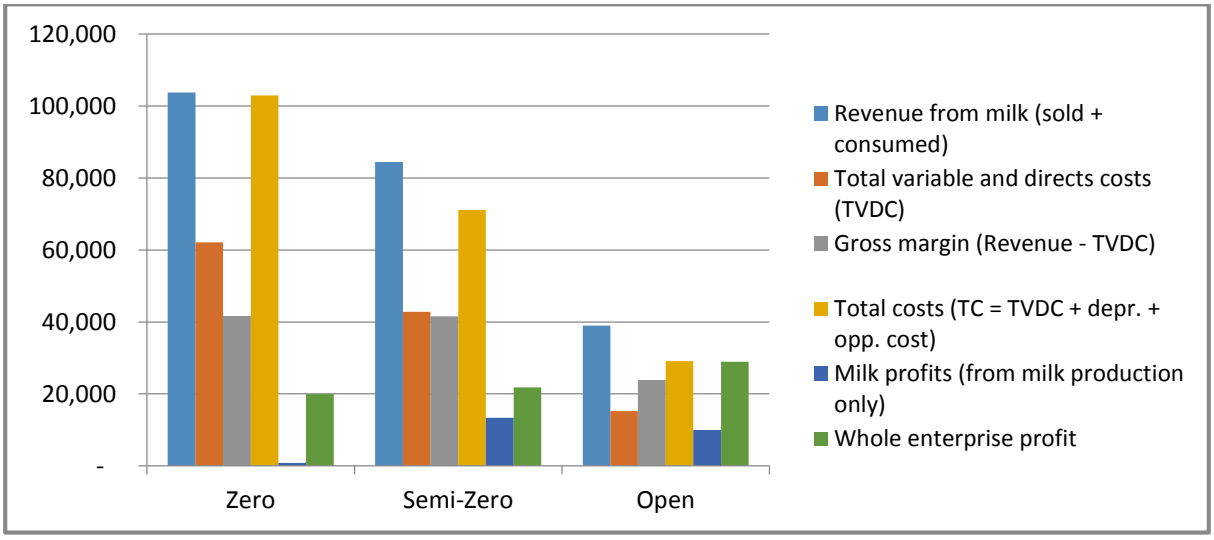
**Figure 2. Share of different components to total cost (TC)**




### 3.4. Returns per lactating cow as a proxy of efficiency in milk production

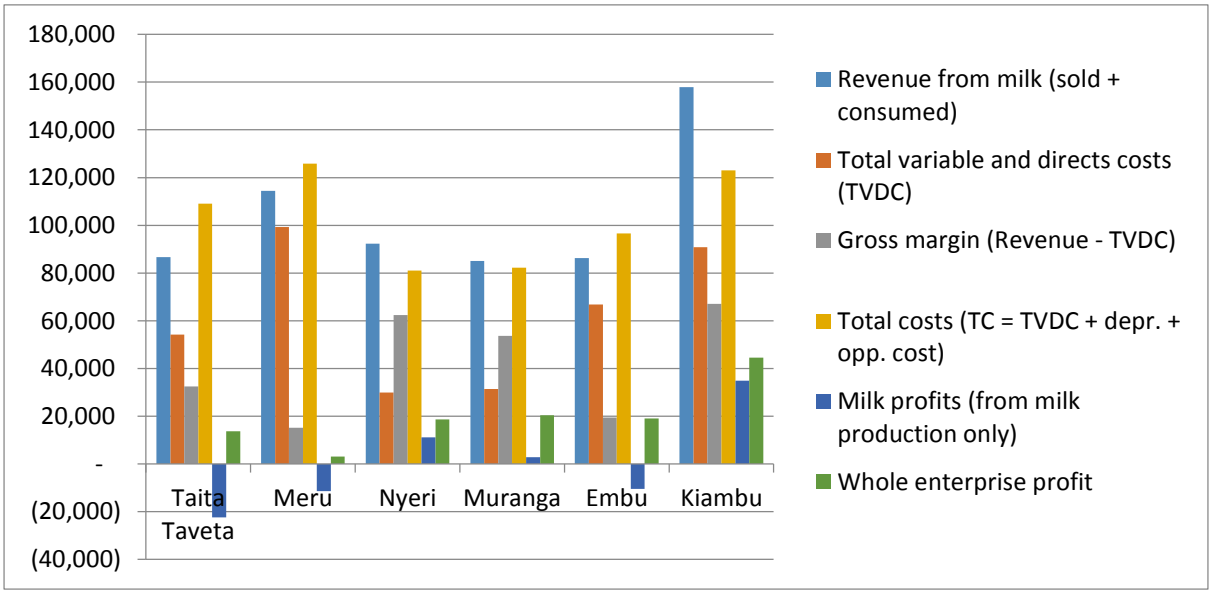
Cost and returns can also be calculated per lactating cow. These returns can be used as a proxy for efficiency. However, this proxy should not be taken as a perfect indicator of efficiency because different counties received different average milk prices, and as this study has shown, milk prices are important in determining returns. As shown in Figure 3, milk revenue from one lactating cow was highest in the zero grazing system (Ksh 103,773/cow/year). This is not surprising considering that zero grazers had the highest average productivity per lactating cow. The cost of producing milk per cow was also highest in this production system. Despite the high costs, this production system recorded the largest gross margin per lactating cow per year (Ksh 41,692) as a result of high milk revenues. When other costs of production were considered (mainly own labour and fodder), the zero grazing producers just managed to break-even, making a small profit of Ksh 809 per cow per year from milk production only.

**Figure 3. Costs and returns in Ksh per lactating cow by production system**




The other production systems made higher profits on average: Ksh 13,354 for semi-zero grazers and Ksh 9,940 for open grazers. There were substantial differences in efficiency even within a production system. For the zero grazers, it is only typical farmers in Kiambu, Nyeri and Muranga that made profit per cow per year in milk production (Figure 4). Producers in Taita Taveta, Meru and Embu were making a loss in milk production. For zero grazers, profit per cow per year was highest in Kiambu at Ksh 34,945 and lowest in Taita Taveta with a loss of Ksh 22,358 per cow per year.

**Figure 4. Costs and returns in Ksh per lactating cow per year for zero grazers**



## 3.5. Effect of changes in cost and returns as a result of changes in cost structure and milk prices

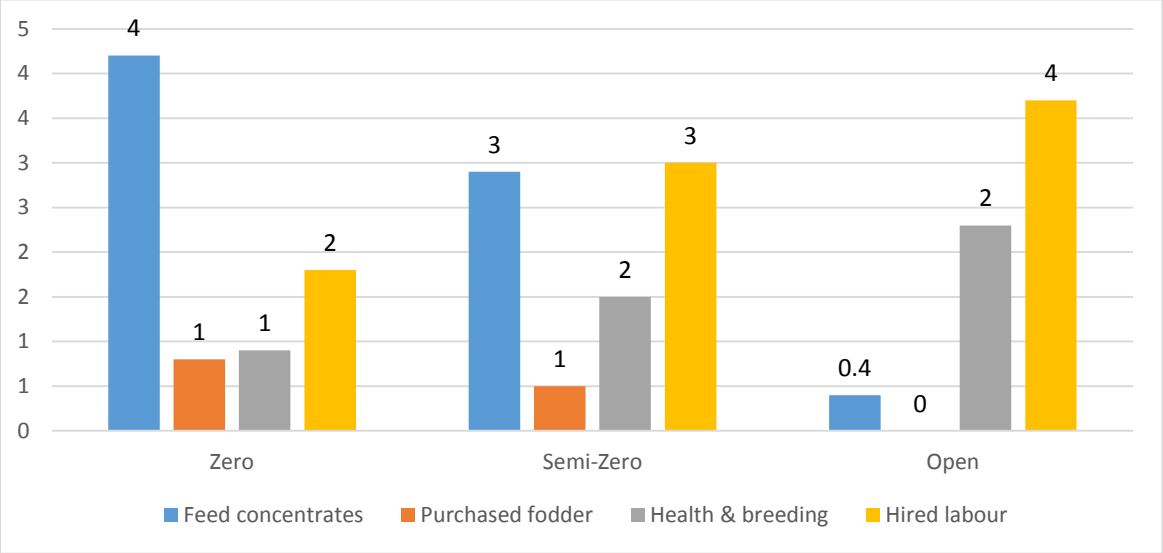
In this section, we simulate the effect of different factors on cost of production, gross margins and profitability. This enables us to single out the areas in which policy interventions could be used to reduce costs and/or increase returns. We simulate the effect of changing individual costs by 10% on TVDC, while keeping the cost of other factors constant. We focus on variable and direct costs only in this case, since adjustments for these factors would be easier for policy.

### 3.5.1 Factors important in determining total variable direct costs (TVDC)

In the previous sections, we identified various factors that are important contributors to TVDC. We consider only four of those: feed concentrates, purchased fodder/pasture, health and breeding costs and hired labour. Figure 5 confirms our earlier results. For zero grazers, the highest reduction in TVDC would come from a reduction in the cost of feed concentrates. If the cost of feed concentrates would be reduced by 10%, TVDC for zero-grazers would reduce by 4%. This is followed by hired labour, which would result in a 2% reduction in TVDC if its cost was reduced by 10%. Even for individual counties that are practising zero-grazing (see Table A6 in the appendix), the same case applies apart from Taita Taveta and Meru counties. In Meru, a reduction on the cost of hired labour by 10% would lead to a reduction of TVDC by 6%, which outweighs the 2% decrease in TVDC as a result of a 10% reduction in cost of feeds.

For semi-zero grazers, a reduction of the cost of hired labour by 10% would have the greatest effect on change of TVDC (3%), followed by feed concentrates at almost the same percentage. However, there are differences when we look at individual counties (Table A7 and A8 in the appendix). For Nakuru, Kisii, Bomet, Nyandarua, and Nandi, it is the reduction in the cost of feed concentrates that would have the greatest effect in reducing TVDC. For the others (Kakamega, Uasin Gishu, Bungoma, Trans Nzoia, Elgeyo Marakwet and Machakos), the greatest decrease in TVDC would come from a reduction in the cost of hired labour.

**Figure 5. Changes in TVDC as a result of reduction in costs by production system (%)**



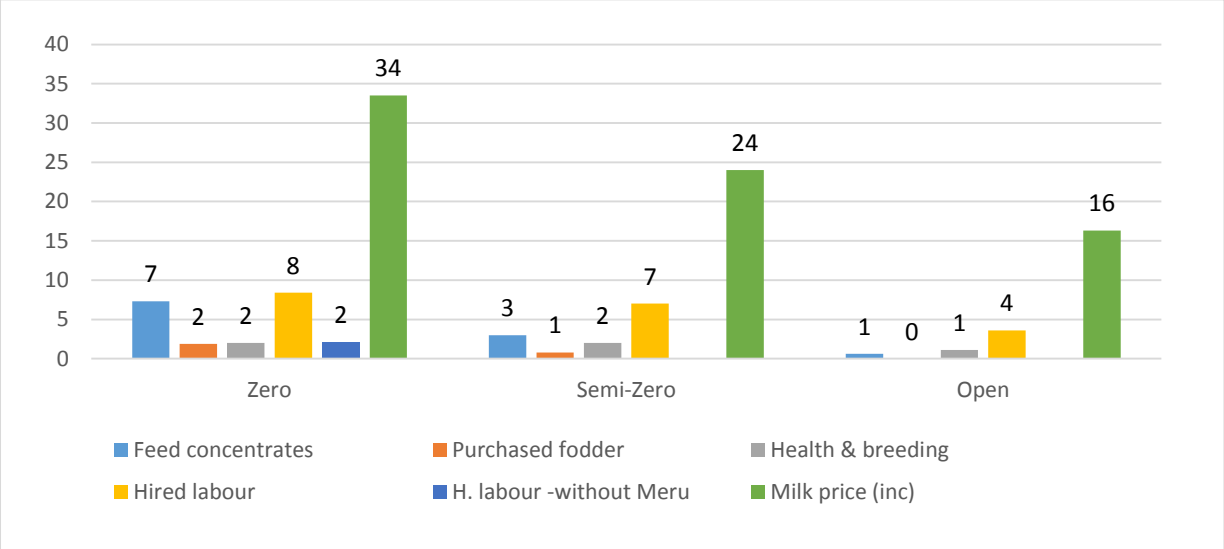

For open grazers, the largest decline in TVDC would clearly emanate from a 10% decrease in the cost of hired labour (4%) followed by cost of health and breeding (2%). Individually, this is the case for Baringo and Narok, while for Migori, a reduction in TVDC can only come from reduction in the cost of health and breeding (Table A9).

### 3.5.2 Factors important in increasing gross margin

Change in factors important in determining TVDC would also be important in determining gross margin. We therefore simulate the effect of a reduction in cost of feeds, pasture, health & breeding and hired labour for gross margins. Like previously, we simulate the effect of a 10% reduction in each of these cost components individually while the other costs remain constant. In addition, we also simulate the effect of a 10% increase in price of milk as costs remain constant. The results are presented by production system in Figure 6. If the cost of feed concentrates would reduce by 10%, the gross margin for zero grazers would increase by 7%. A 10% reduction in cost of hired labour would result in a higher percentage increase in gross margin (8%) but this is mainly driven by production in Meru County where hired labour accounts for about 48% of TVDC . When we simulate the effect of a reduction in the cost of hired labour for zero grazers without Meru County, this now translates to a 2% increase in gross margin. The cost component whose reduction would lead to the highest increase in gross

margin for both semi-zero grazers and open grazers is hired labour at 7% and 4%, respectively. Results by county are shown in Tables A6, A7, A8 and A9.

**Figure 6. Changes in gross margins as a result of reduction in costs and milk price increase, by production system (%)**



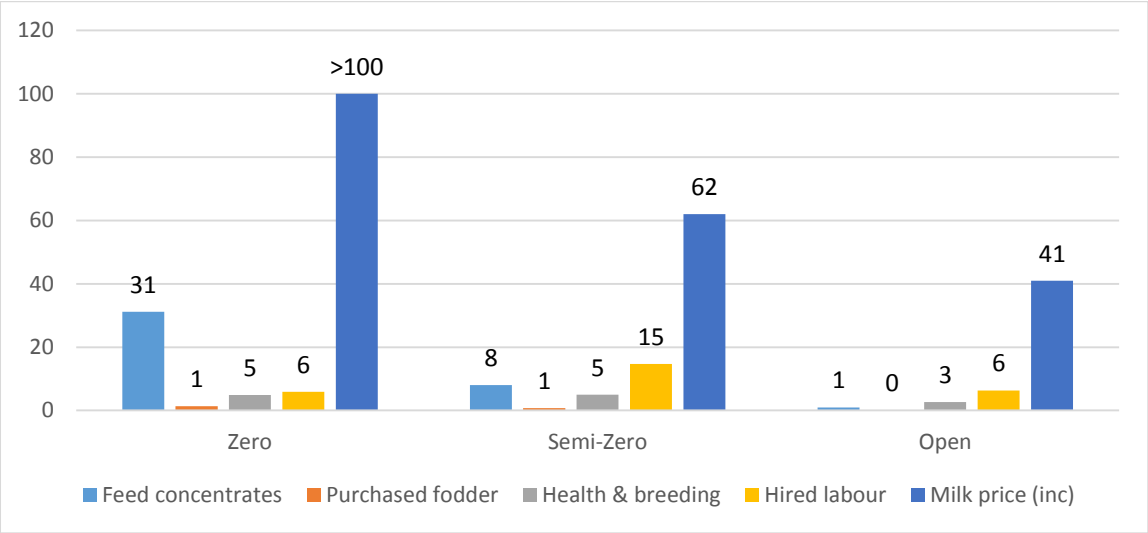

For all production systems, however, the effect of an increase in price on gross margin is much higher than the effect of any cost component in increasing gross margins. A 10% increase in price of milk would translate to a 34% increase in gross margins for zero grazers, 24% for semi-zero grazers and a 16% for open grazers. For zero grazers, the greatest increase in gross margin from a price increase would be observed in Meru County at 75%. For semi-zero grazers, the effect is much lower for the other counties apart from Uasin Gishu where a 10% increase in price of milk would result in a 62% increase in profits.

### 3.5.3 Factors important in increasing milk profits

When considering milk profits, we get similar results as in the case of gross margins. Milk profits would be increased the most if the price of milk increased relative to a reduction in the important variable and direct cost components. For instance, an increase in price of milk by 10% would result in more than doubling of milk profits for zero grazers (Figure 7). Individually, however, it is important to remember that only in three zero-grazing production counties did typical farmers register milk profits. These are Nyeri, Murang'a and Kiambu. Among these, an increase in price of milk would have the highest increase in profits in Muranga

(Table A6), where a 10% increase in price would result in more than 100% increase in profits. For Nyeri, it would result in 83% increase and 45% in Kiambu. As observed earlier, feed concentrates are the most important cost component for zero-grazers. Similarly, a reduction in their cost by 10% would result in an increase in milk profits by 31%, followed by the effect of cost of hired labour reduction at 6%.

**Figure 7. Changes in milk profits as a result of reduction in costs and milk price increase, by production system (%)**

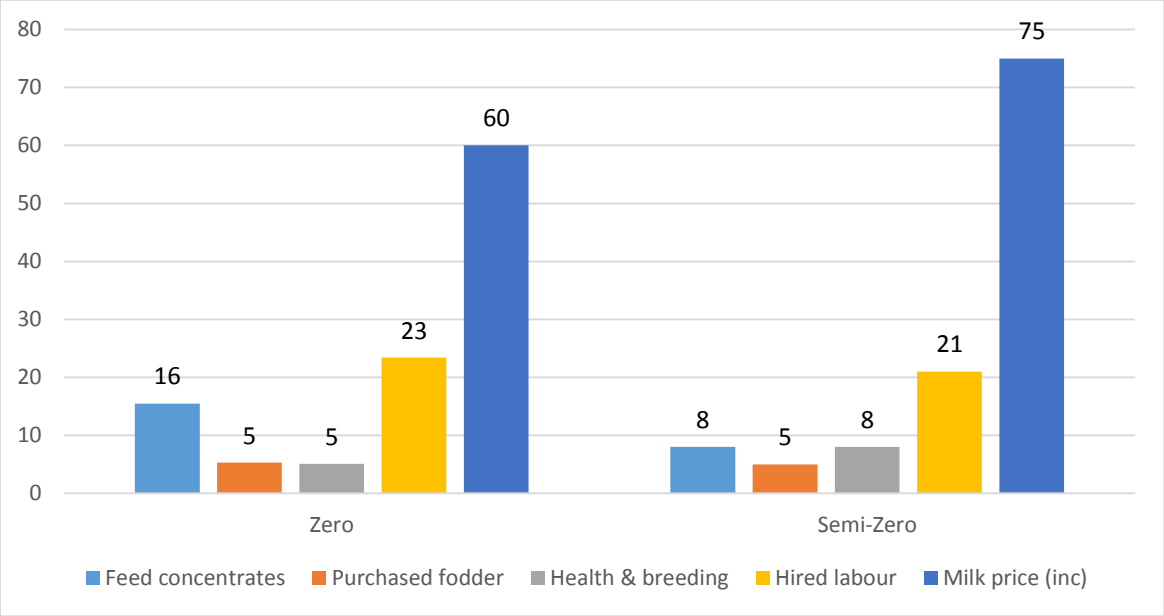



An increase in price of milk by 10% would increase milk profits by 62% for semi-zero grazers and 41% for open grazers (Figure 7). For these two production systems, the most important direct cost component is hired labour. Changes of profits due to changes in various cost components and milk price for individual counties are shown in Tables A7 and A8.

### 3.5.4 Factors important in reducing economic losses in milk production

For zero and semi-zero grazers, there are counties that registered losses (see Tables A1, A2 and A3). These are Taita Taveta, Meru and Embu for zero-grazers, and Nakuru, Uasin Gishu, Nyandarua and Machakos for the semi-zero grazers. The effects of changes of various factors in reducing this loss are presented in Figure 8.

**Figure 8. Changes in milk losses as a result of reduction in costs and milk price increase, by production system (%)**




Among the factors considered, the most important one in reducing the losses for zero-grazers is an increase in price of milk, which would reduce milk losses by 60%. Hired labour comes second at 23% followed by feed concentrates at 16%. Looking at individual counties, the effect of a milk price increase of 10% is the only factor that changes the dynamics, causing typical farmers in Meru to move from loss making to making a profit (Table A6).

For semi-zero grazers, a 10% increase in milk price would result in loss reduction by 75% for the counties that had registered a loss (Figure 8). The next important factor is hired labour that would reduce losses by 21%. Looking at individual counties (Tables A7 and A8), initial losses for Nakuru and Nyandarua counties were quite small (Ksh 0.1 and Ksh 0.3 per litre, respectively). For these two counties, a reduction of the considered cost components and milk price increase caused producers in these counties to move from loss making to profit making. For Uasin Gishu and Machakos, milk price increase had the largest impact in reducing losses.

## 4. Challenges faced by dairy farmers

In addition to collecting information on costs and returns, this study revealed challenges that dairy farmers are experiencing. These are highlighted below:

1. Much as this study showed that traders pay better prices, some farmers had experiences of traders who bought milk at low prices especially in the absence of competition from processors and cooperative societies. This can especially be the case in relatively small towns with few traders.
2. In addition, poor infrastructure makes this issue worse as farmers may have no alternative but to wait for a trader to buy at the farm gate.
3. In many counties, farmers reported experience with poor quality feeds. This may imply cases of counterfeits in the market or just feed products that don't meet standards.
4. Inadequate extension services exacerbated by few or no livestock extension officers has led to poor livestock husbandry and farming practices which might have affected productivity.
5. Farmers observed that droughts have become more frequent, interrupting usual season cycles. This results in periods of pastures unavailability, which would otherwise have adequate pasture under normal weather conditions.
6. In some counties with low milk productivity such as Migori, farmers lamented a lack of organized milk markets.
7. Farmers reiterated the high cost of animal feeds and other dairy production inputs.
8. Good breeds are not easily available in counties that are far from major cities. This, coupled with limited access to and high costs of A.I. services means that farmers would not enjoy high productivity that comes with improved breeds.
9. A decline in land sizes that is occurring in many areas means that farmers are continuously reducing their dairy stocks to sometimes uneconomic units. In open grazing systems, conversion of community grazing land to other uses means that farmers have to reduce their herd sizes.

## 5. Conclusions and Recommendations

### 5.1 Conclusions

In this study, we analysed the costs and returns of typical dairy farmers from 20 counties. The results are presented mainly by production system. However, since there are substantial differences within a production system as far as costs, gross margins and economic returns are considered, we also highlighted performance at county level. Such differences within a production system would not be observed if analysis was only done at a higher level of aggregation such as a production system.

Results showed that cost of milk production in Ksh per litre of milk produced increased with intensity: it was highest for zero-grazers and lowest for open-grazers. This was the case whether the analysis took into account TVDC or TC. While zero grazers were spending Ksh 19 to produce a litre of milk, semi-zero grazers spent Ksh 17.2 and the open grazers, Ksh 10.

If gross margins, which are a measure of accounting returns, were to be taken as the measure of profitability, then milk production is a profitable enterprise for typical farmers in all the counties studied. On average, gross margins were highest for open grazers at Ksh 22.8 and lowest for zero grazers at Ksh 12.4 per litre. Important determinants of gross margins were the average milk prices in addition to TVDC. Economic returns would, however, be a better indicator of profitability as they take into account own factors of production. When this was considered, the zero-grazers would barely break even, making a small loss of Ksh 0.6 per litre. This shows the importance of own factors of production such as family labour and own fodder/pasture in dairy production especially for zero-grazers. Typical farmers in the other production systems had positive milk profits.

Feed concentrates formed the largest component of TVDC for the zero-grazers (41.8%) while it was hired labour for the other production systems. When considering TC, family labour was the biggest component of cost across all production systems. Total labour (family plus hired) contributed more than a third of TC for all production systems, ranging from 38.1% for the zero grazers to 51% for the open grazers. Simulations confirm the importance of various cost components to TVDC and returns. For instance, the largest reduction in TVDC for zero-grazers would come from a reduction in cost of feed concentrates, while it would be hired labour for the other production systems. This same effect is translated to returns. However, the effect of an increase in price on returns (gross margins and milk profits) was found to be much

higher than the effect of a reduction in any cost component. The findings were similar when we considered factors that would be critical in reducing losses in milk production. This shows the importance of improved milk prices in dairy enterprise returns.

### 5.2 Recommendations

With increasing population and shrinking land sizes, dairy production will have to become more and more intensive in Kenya. However, our results show that this shift comes with higher costs and lower returns per litre. Policy actions are thus needed so as to address this and improve returns per unit for the more intensive systems. Our results show that the main components of cost for the more intensive production systems are feed concentrates and labour. To address the issue of high cost of animal feeds, it would be important to look at their tax regimes and see if some taxes can be reduced/scrapped, either for the finished feed concentrates, or raw materials used in their formulation. Another option is to move towards own feed formulation, either at farmer or cooperative level, which would likely reduce the cost of feeds.

Labour is an important cost component for zero-grazers and farmers practising other production systems. Small-scale labour-saving technologies should be encouraged to address this. Such technologies, for instance chaff cutters, would reduce manual cutting of feed and so save on time. In fact, feeding is one of the largest components of labour in dairy farming. In addition, own feed formulation would also reduce labour cost associated with gathering of fodder.

In comparison to cost reduction, this study has shown that price is a more important driver of dairy returns. Counties that received high milk prices registered good returns on average even in cases where their cost of production was high. This is mainly the case where farmers are selling directly to traders or consumers. On the other hand, prices from processors and dairy cooperatives are quite low in comparison. In addition to processors buying at a lower price, the cooperatives also deduct a management fee further reducing the net amount received by the farmers. While the cost of processing is not known, it worth noting that the producer prices paid by processors are on average just a third of the retail prices of pasteurized milk.

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## Appendix Tables

**Table A1. Costs and returns in KSh per litre of milk produced for zero grazers**

| County | T/Taveta | Meru | Nyeri | Muranga | Embu | Kiambu |
|---|---|---|---|---|---|---|
| Revenue from milk (sold + consumed) | 34.6 | 35 | 26.7 | 27 | 29 | 35.8 |
| Purchased fodder/pasture | 3.6 | 0.7 | 0 | 0 | 3.4 | 3 |
| Feed concentrates | 2.2 | 6.1 | 5 | 5.5 | 9.3 | 13.6 |
| Mineral salts | 1 | 1.3 | 1.6 | 1.7 | 0.6 | 1.1 |
| Water (purchased) | 11.5 | 0.7 | 0.3 | 0 | 0.5 | 0 |
| Health and breeding costs | 2.5 | 2.6 | 0.9 | 1 | 1.8 | 1.1 |
| Milking jelly | 0.2 | 0.4 | 0.3 | 0.1 | 0.5 | 0.2 |
| Hired labor | 0 | 18.3 | 0 | 1.5 | 6.1 | 0.8 |
| Repairs on fixed assets | 0.4 | 0.1 | 0.2 | 0.1 | 0.3 | 0.3 |
| Other direct costs (e.g. electricity, fuel, ropes ) | 0.4 | 0 | 0.3 | 0 | 0 | 0.5 |
| Total variable and directs costs (TVDC) | 21.7 | 30.4 | 8.7 | 10 | 22.5 | 20.6 |
| Gross margin (Revenue - TVDC) | 12.9 | 4.6 | 18.1 | 17 | 6.5 | 15.2 |
| Depreciation (fixed assets) | 0.5 | 0.3 | 0.1 | 0.4 | 0.2 | 0.1 |
| Own fodder/pasture | 7 | 7.8 | 2.6 | 5.3 | 6.8 | 1.7 |
| Family labor | 14.4 | 0 | 12.2 | 10.5 | 3 | 5.4 |
| Total costs (TC = TVDC + depr. + opp. cost) | 43.5 | 38.5 | 23.5 | 26.1 | 32.5 | 27.9 |
| Milk profits (Revenue - TC) | -8.9 | -3.5 | 3.2 | 0.9 | -3.5 | 7.9 |
| Other revenue (sale of livestock, manure, bull serv.) | 14.4 | 4.4 | 2.2 | 5.6 | 9.9 | 2.2 |
| Whole enterprise profits | 5.4 | 1 | 5.4 | 6.5 | 6.4 | 10.1 |
| Gross margin as a proportion of TVDC (%) | 59.4 | 15.1 | 208.0 | 170.0 | 28.9 | 73.8 |
| Gross margin rate as a proportion of revenue (%) | 37.3 | 13.1 | 67.8 | 63.0 | 22.4 | 42.5 |
| Milk profits as a proportion of TVDC (%) | -41.0 | -11.5 | 36.8 | 9.0 | -15.6 | 38.3 |
| Milk profits as a proportion of revenue (%) | -25.7 | -10.0 | 12.0 | 3.3 | -12.1 | 22.1 |

**Table A2. Costs and returns in KSh per litre of milk produced for semi-zero small-scale grazers**

| County | Nakuru | Kisii | Kakamega | Bomet | U/Gishu | Average |
|---|---|---|---|---|---|---|
| Revenue from milk (sold + consumed) (Ksh/litre) | 25.5 | 44.9 | 55.9 | 30.5 | 24.4 | 36.2 |
| Purchased fodder/pasture | 1.2 | 3.2 | 2.7 | 0 | 0.3 | 1.5 |
| Feed concentrates | 6.8 | 6.1 | 8.6 | 5.1 | 3.6 | 6.0 |
| Mineral salts | 1.7 | 1.7 | 1.6 | 1.9 | 2.6 | 1.9 |
| Water (purchased) | 0.6 | 0 | 0 | 2 | 0 | 0.5 |
| Health and breeding costs | 1.7 | 2.7 | 3.4 | 2.8 | 1 | 2.3 |
| Milking jelly | 0.3 | 0 | 0.4 | 0.2 | 0.1 | 0.2 |
| Hired labour | 0 | 0.4 | 18.2 | 0 | 12 | 6.1 |
| Repairs on fixed assets | 0.8 | 0.6 | 1 | 0.5 | 0.8 | 0.7 |
| Other direct costs (e.g. electricity, fuel, ropes ) | 0.1 | 0.1 | 0.1 | 0 | 0.1 | 0.1 |
| Total variable and directs costs (TVDC) | 13.2 | 14.8 | 36.2 | 12.4 | 20.5 | 19.4 |
| Gross margin (Revenue - TVDC) | 12.3 | 30.1 | 19.7 | 18.1 | 4 | 16.8 |
| Depreciation (fixed assets) | 0.1 | 0.4 | 0.3 | 1.2 | 0.5 | 0.5 |
| Own fodder/pasture | 2.3 | 3 | 7.7 | 3.7 | 5 | 4.3 |
| Family labour | 10 | 8.1 | 0 | 8 | 1.7 | 5.6 |
| Total costs (TC = TVDC + depr. + opp. cost) | 25.6 | 26.4 | 44.2 | 25.2 | 27.7 | 29.8 |
| Milk profits (Revenue - TC) | -0.1 | 18.6 | 11.7 | 5.2 | -3.3 | 6.4 |
| Other revenue (sale of livestock, manure, bull serv.) | 1.9 | 5.9 | 3.4 | 1.3 | 1 | 2.7 |
| Whole enterprise profits | 1.8 | 24.4 | 15.1 | 6.6 | -2.3 | 9.1 |
| Gross margin as a proportion of TVDC (%) | 93.2 | 203.4 | 54.4 | 146 | 19.5 | 103.3 |
| Gross margin rate as a proportion of revenue (%) | 48.2 | 67 | 35.2 | 59.3 | 16.4 | 45.3 |
| Milk profits as a proportion of TVDC (%) | -0.8 | 125.7 | 32.3 | 41.9 | -16.1 | 36.6 |
| Milk profits as a proportion of revenue (%) | -0.4 | 41.4 | 20.9 | 17 | -13.5 | 13.1 |

**Table A3. Costs and returns in KSh per litre of milk produced for semi-zero medium-scale grazers**

| County | Nyandarua | Bungoma | Nandi | T/Nzoia | E/ Marakwet | Machakos | Average |
|---|---|---|---|---|---|---|---|
| Revenue from milk (sold + consumed) (Ksh/liter) | 23.4 | 47 | 30.3 | 30.7 | 29.4 | 32.7 | 32 |
| Purchased fodder/pasture | 0 | 1.1 | 0 | 0 | 0 | 2.7 | 1 |
| Feed concentrates | 4.5 | 5.4 | 2.5 | 4.8 | 2 | 1.1 | 3 |
| Mineral salts | 1.6 | 0.9 | 2.1 | 0.5 | 0.3 | 0.1 | 1 |
| Water (purchased) | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Health and breeding costs | 3.2 | 0.7 | 2.3 | 2.5 | 1.8 | 2.7 | 2 |
| Milking jelly | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0 |
| Hired labor | 0 | 7.2 | 0 | 13.8 | 12.1 | 9.7 | 7 |
| Repairs on fixed assets | 0.8 | 0.5 | 0.7 | 0.1 | 0.4 | 0.4 | 0 |
| Other direct costs (e.g. electricity, fuel, ropes ) | 0.1 | 0.2 | 0 | 0.1 | 0.2 | 1.8 | 0 |
| Total variable and directs costs (TVDC) | 10.3 | 16.1 | 7.8 | 21.9 | 16.9 | 18.7 | 15 |
| Gross margin (Revenue - TVDC) | 13.2 | 31 | 22.5 | 8.9 | 12.4 | 13.9 | 17 |
| Depreciation (fixed assets) | 0.4 | 0.2 | 0.2 | 0 | 0.2 | 0.4 | 0 |
| Own fodder/pasture | 2.2 | 5.8 | 6.4 | 6.2 | 4.9 | 6 | 5 |
| Family labor | 10.9 | 4.3 | 12.5 | 0.3 | 2 | 9.7 | 7 |
| Total costs (TC = TVDC + depr. + opp. cost) | 23.7 | 26.4 | 26.9 | 28.5 | 24 | 34.8 | 27 |
| Milk profits (Revenue - TC) | -0.3 | 20.6 | 3.4 | 2.2 | 5.4 | -2.1 | 5 |
| Other revenue (sale of livestock, manure, bull serv.) | 3 | 8.3 | 3.5 | 3 | 6.8 | 1 | 4 |
| Whole enterprise profits | 2.6 | 28.9 | 6.9 | 5.2 | 12.2 | -1.1 | 9 |
| Gross margin as a proportion of TVDC (%) | 128.2 | 192.5 | 288.5 | 40.6 | 73.4 | 74.3 | 133 |
| Gross margin as a proportion of revenue (%) | 56.4 | 66 | 74.3 | 29 | 42.2 | 42.5 | 52 |
| Milk profits as a proportion of TVDC (%) | -2.9 | 128 | 43.6 | 10 | 32 | -11.2 | 33 |
| Milk profits as a proportion of revenue (%) | -1.3 | 43.8 | 11.2 | 7.2 | 18.4 | -6.4 | 12 |

**Table A4. Costs and returns in KSh per litre of milk produced for open grazers**

| County | Migori | Baringo | Narok | Average |
|---|---|---|---|---|
| Revenue from milk (sold + consumed) (Ksh/liter) | 40 | 27.9 | 30.4 | 32.8 |
| Purchased fodder/pasture | 0 | 0 | 0 | 0 |
| Feed concentrates | 0 | 2.1 | 0 | 0.7 |
| Mineral salts | 0 | 0.9 | 1.4 | 0.8 |
| Water (purchased) | 0 | 0.3 | 0 | 0.1 |
| Health and breeding costs | 1.2 | 2 | 3.1 | 2.1 |
| Milking jelly | 0 | 0.1 | 0.2 | 0.1 |
| Hired labor | 0 | 10.4 | 4.3 | 4.9 |
| Repairs on fixed assets | 2.2 | 0.1 | 0.2 | 0.8 |
| Other direct costs (e.g. electricity, fuel, ropes ) | 1.3 | 0 | 0.2 | 0.5 |
| Total variable and directs costs (TVDC) | 4.7 | 15.9 | 9.4 | 10 |
| Gross margin (Revenue - TVDC) | 35.3 | 12 | 21 | 22.8 |
| Depreciation (fixed assets) | 0.2 | 0 | 0.1 | 0.1 |
| Own fodder/pasture | 4.4 | 1.7 | 13.4 | 6.5 |
| Family labor | 22.2 | 2.4 | 0 | 8.2 |
| Total costs (TC = TVDC + depr. + opp. cost) | 31.6 | 20 | 22.9 | 24.8 |
| Milk profits (Revenue - TC) | 8.4 | 7.8 | 7.5 | 7.9 |
| Other revenue (sale of livestock, manure, bull serv.) | 54.1 | 4.7 | 9.8 | 22.9 |
| Whole enterprise profits | 62.5 | 12.6 | 17.3 | 30.8 |
| Gross margin as a proportion of TVDC (%) | 751.1 | 75.5 | 223.4 | 350 |
| Gross margin as a proportion of revenue (%) | 88.3 | 43 | 69.1 | 66.8 |
| Milk profits as a proportion of TVDC (%) | 178.7 | 49.1 | 79.8 | 102.5 |
| Milk profits as a proportion of revenue (%) | 21 | 28 | 24.7 | 24.5 |

**Table A5. Share of different cost components to TVDC, by county (%)**

| County | Purch. fodder | Feed conc. | Mineral salts | Water (purch.) | Health & breeding | Milking jelly | Hired labor | Repairs | Other direct costs |
|---|---|---|---|---|---|---|---|---|---|
| Taita Taveta | 17 | 10 | 4 | 53 | 11 | 1 | 0 | 2 | 2 |
| Meru | 2 | 20 | 4 | 2 | 9 | 1 | 60 | 0 | 0 |
| Embu | 15 | 41 | 3 | 2 | 8 | 2 | 27 | 1 | 0 |
| Muranga | 0 | 56 | 17 | 0 | 10 | 1 | 15 | 1 | 0 |
| Nyeri | 0 | 58 | 18 | 4 | 10 | 3 | 0 | 3 | 4 |
| Kiambu | 15 | 66 | 5 | 0 | 5 | 1 | 4 | 1 | 2 |
| Nakuru | 9 | 52 | 13 | 5 | 13 | 3 | 0 | 6 | 0 |
| Kisii | 21 | 41 | 12 | 0 | 18 | 0 | 3 | 4 | 1 |
| Kakamega | 8 | 24 | 5 | 0 | 10 | 1 | 50 | 3 | 0 |
| Bomet | 0 | 41 | 15 | 16 | 22 | 1 | 0 | 4 | 0 |
| Uasin Gishu | 2 | 18 | 13 | 0 | 5 | 1 | 59 | 4 | 0 |
| Nyandarua | 0 | 44 | 15 | 0 | 31 | 1 | 0 | 8 | 1 |
| Bungoma | 7 | 33 | 5 | 0 | 4 | 1 | 45 | 3 | 1 |
| Nandi | 0 | 33 | 27 | 0 | 30 | 2 | 0 | 9 | 0 |
| Trans Nzoia | 0 | 22 | 2 | 0 | 11 | 1 | 63 | 0 | 0 |
| E/Marakwet | 0 | 12 | 2 | 0 | 11 | 1 | 71 | 2 | 1 |
| Machakos | 15 | 6 | 1 | 0 | 14 | 1 | 52 | 2 | 10 |
| Narok | 0 | 0 | 15 | 0 | 33 | 2 | 46 | 2 | 2 |
| Migori | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 47 | 28 |
| Baringo | 0 | 13 | 6 | 2 | 12 | 1 | 66 | 0 | 0 |

**Table A6. Changes in TVDC and returns as a result of reduction in costs and milk price increase for zero-grazers**

| | T/Taveta | Meru | Nyeri | Muranga | Embu | Kiambu | Overall |
|---|---|---|---|---|---|---|---|
| | % reduction in **TVDC** as a result of 10% reduction in cost of: | | | | | | |
| Feed concentrates | 1 | 2 | 5.8 | 5.6 | 4.1 | 6.6 | 4 |
| Pastured fodder | 1.7 | 0.2 | 0 | 0 | 1.5 | 1.5 | 1 |
| Health & breeding | 1.1 | 0.9 | 1 | 1 | 0.8 | 0.5 | 1 |
| Hired labor | 0 | 6 | 0 | 1.5 | 2.7 | 0.4 | 2 |
| | % increase in **GM** as a result of 10% change in: | | | | | | |
| Feed concentrates | 1.7 | 13.3 | 2.8 | 3.2 | 14.2 | 8.9 | 7 |
| Pastured fodder | 2.8 | 1.6 | 0 | 0 | 5.2 | 2 | 2 |
| Health & breeding | 1.9 | 5.6 | 0.5 | 0.6 | 2.8 | 0.7 | 2 |
| Hired labor | 0 | 39.7 | 0 | 0.9 | 9.3 | 0.5 | 8 |
| Milk price (inc) | 26.7 | 75.7 | 44.4 | 15.8 | 14.8 | 23.5 | 33 |
| Initial profit/loss/lt | -8.9 | -3.5 | 3.2 | 0.9 | -3.5 | 7.9 | -1 |
| | % increase in **Milk Profits** as a result of 10% change in: | | | | | | |
| Feed concentrates | -- | -- | 15.6 | 61 | -- | 17.1 | 31 |
| Pastured fodder | -- | -- | 0 | 0 | -- | 3.8 | 1 |
| Health & breeding | -- | -- | 2.6 | 10.7 | -- | 1.4 | 5 |
| Hired labor | -- | -- | 0 | 16.8 | -- | 1 | 6 |
| Milk price (inc) | -- | -- | 82.6 | > 100 | -- | 45.2 | > 100 |
| | % reduction in **Milk Losses** as a result of 10% change in: | | | | | | |
| Feed concentrates | 2.4 | 17.6 | -- | -- | 26.5 | -- | 16 |
| Pastured fodder | 4 | 2.2 | -- | -- | 9.6 | -- | 5 |
| Health & breeding | 2.8 | 7.5 | -- | -- | 5.2 | -- | 5 |
| Hired labor | 0 | 52.8 | -- | -- | 17.3 | -- | 23 |
| Milk price (inc) | 38.8 | + + | -- | -- | 82.9 | -- | 60 |

**Table A7. Changes in TVDC and returns as a result of reduction in costs and milk price increase for semi-zero-grazers, small-scale**

| | Nakuru | Kisii | Kakamega | Bomet | U/Gishu | Overall |
|---|---|---|---|---|---|---|
| | % reduction in **TVDC** as a result of 10% reduction in cost of: | | | | | |
| Feed concentrates | 5.2 | 4.1 | 2.4 | 4.1 | 1.8 | 4 |
| Pastured fodder | 0.9 | 2.1 | 0.8 | 0 | 0.2 | 1 |
| Health & breeding | 1.3 | 1.8 | 1 | 2.2 | 0.5 | 1 |
| Hired labour | 0 | 0.3 | 5 | 0 | 5.9 | 2 |
| | % increase in **GM** as a result of 10% change in: | | | | | |
| Feed concentrates | 5.5 | 2 | 4.4 | 2.8 | 9.1 | 8 |
| Pastured fodder | 1 | 1 | 1.4 | 0 | 0.8 | 1 |
| Health & breeding | 1.4 | 0.9 | 1.7 | 1.5 | 2.5 | 3 |
| Hired labour | 0 | 0.1 | 9.2 | 0 | 30.3 | 19 |
| Milk price (inc) | 20.7 | 14.9 | 28.3 | 16.8 | 61.6 | 29 |
| Initial profit/loss/lt | -0.1 | 18.6 | 11.7 | 5.2 | -3.3 | 6 |
| | % increase in **Milk Profits** as a result of 10% change in: | | | | | |
| Feed concentrates | -- | 3.3 | 7.4 | 9.7 | -- | 7 |
| Pastured fodder | -- | 1.7 | 2.3 | 0 | -- | 1 |
| Health & breeding | -- | 1.5 | 2.9 | 5.3 | -- | 3 |
| Hired labour | -- | 0.2 | 15.5 | 0 | -- | 5 |
| Milk price (inc) | -- | 24.2 | 47.8 | 58.2 | -- | 43 |
| | % reduction in **Milk Losses** as a result of 10% change in: | | | | | |
| Feed concentrates | + + | -- | -- | -- | 11.1 | 6 |
| Pastured fodder | + + | -- | -- | -- | 1 | 1 |
| Health & breeding | + + | -- | -- | -- | 3 | 2 |
| Hired labour | 0 | -- | -- | -- | 36.9 | 10 |
| Milk price (inc) | + + | -- | -- | -- | 75.2 | 75 |

**Table A8. Changes in TVDC and returns as a result of reduction in costs and milk price increase for semi-zero-grazers, medium-scale**

| | Nyandarua | Bungoma | Nandi | T/Nzoia | E/Marakwet | Machakos | Overall |
|---|---|---|---|---|---|---|---|
| | % reduction in **TVDC** as a result of 10% reduction in cost of: | | | | | | |
| Feed concentrates | 4.4 | 3.3 | 2.6 | 2.2 | 1.2 | 0.5 | 2 |
| Pastured fodder | 0 | 0.7 | 0 | 0 | 0 | 1.2 | 0 |
| Health & breeding | 3.1 | 0.4 | 2.4 | 1.1 | 1.1 | 1.2 | 2 |
| Hired labor | 0 | 4.5 | 0 | 6.3 | 7.1 | 4.4 | 4 |
| | % increase in **GM** as a result of 10% change in: | | | | | | |
| Feed concentrates | 3.4 | 1.7 | 1.2 | 5.4 | 1.6 | 1 | 2 |
| Pastured fodder | 0 | 0.4 | 0 | 0 | 0 | 2.5 | 1 |
| Health & breeding | 2.4 | 0.2 | 1.1 | 2.8 | 1.5 | 2.5 | 2 |
| Hired labor | 0 | 2.3 | 0 | 15.6 | 9.7 | 9 | 6 |
| Milk price (inc) | 17.8 | 15.2 | 14.8 | 34.7 | 23.6 | 30.3 | 23 |
| Initial profit/loss/lt | -0.3 | 20.6 | 1.3 | 2.2 | 5.4 | -5.3 | 4 |
| | % increase in **Milk Profits** as a result of 10% change in: | | | | | | |
| Feed concentrates | . | 2.6 | 19.3 | 21.5 | 3.7 | -- | 12 |
| Pastured fodder | . | 0.5 | 0 | 0 | 0 | -- | 0 |
| Health & breeding | . | 0.3 | 17.8 | 10.9 | 3.4 | -- | 8 |
| Hired labor | . | 3.5 | 0 | 61.3 | 22.3 | -- | 22 |
| Milk price (inc) | . | 22.8 | >100 | >100 | 54.2 | -- | >100 |
| | % reduction in **Milk Losses** as a result of 10% change in: | | | | | | |
| Feed concentrates | + + | -- | -- | -- | -- | 2 | 2 |
| Pastured fodder | 0 | -- | -- | -- | -- | 5.2 | 3 |
| Health & breeding | + + | -- | -- | -- | -- | 5 | 5 |
| Hired labor | 0 | -- | -- | -- | -- | 18.3 | 9 |
| Milk price (inc) | + + | -- | -- | -- | -- | 61.7 | 62 |

**Table A9. Changes in TVDC and returns as a result of reduction in costs and milk price increase for open-grazers**

| | Migori | Baringo | Narok | Overall |
|---|---|---|---|---|
| | % reduction in **TVDC** as a result of 10% reduction in cost of: | | | |
| Feed concentrates | 0 | 1.3 | 0 | 0 |
| Pastured fodder | 0 | 0 | 0 | 0 |
| Health & breeding | 2.5 | 1.2 | 3.3 | 2 |
| Hired labor | 0 | 6.6 | 4.6 | 4 |
| | % increase in **GM** as a result of 10% change in: | | | |
| Feed concentrates | 0 | 1.7 | 0 | 1 |
| Pastured fodder | 0 | 0 | 0 | 0 |
| Health & breeding | 0.3 | 1.6 | 1.5 | 1 |
| Hired labor | 0 | 8.7 | 2 | 4 |
| Milk price (inc) | 11.3 | 23.2 | 14.5 | 16 |
| Initial profit/loss/lt | 8.4 | 7.8 | 7.5 | 8 |
| | % increase in **Milk Profits** as a result of 10% change in: | | | |
| Feed concentrates | 0 | 2.7 | 0 | 1 |
| Pastured fodder | 0 | 0 | 0 | 0 |
| Health & breeding | 1.4 | 2.5 | 4.1 | 3 |
| Hired labor | 0 | 13.3 | 5.7 | 6 |
| Milk price (inc) | 47.7 | 35.6 | 40.5 | 41 |