EGERTON  **UNIVERSITY**

TEGEMEO INSTITUTE OF AGRICULTURAL POLICY AND DEVELOPMENT

WPS 43/2011

PRODUCTIVITY TRENDS AND PERFORMANCE OF DAIRY FARMING IN KENYA

Stella Wambugu, Lilian Kirimi and Joseph Opiyo

PRODUCTIVITY TRENDS AND PERFORMANCE OF DAIRY FARMING IN KENYA

Stella Wambugu, Lilian Kirimi and Joseph Opiyo

WPS 43/2011

Tegemeo Institute of Agricultural Policy and Development
P.O Box 20498, 00200, Nairobi, Kenya
Tel: +254 20 2717818/76; Fax: +254 20 2717819
E-mail: Egerton@tegemeo.org

Tegemeo Institute

Tegemeo Institute of Agricultural Policy and Development is a Policy Research Institute under Egerton University with a mandate to undertake empirical research and analysis on contemporary economic and agricultural policy issues in Kenya. The institute is widely recognized as a centre of excellence in policy analysis on the topical agricultural issues of the day, and in its wide dissemination of findings to government and other key stakeholders with a view to influencing policy direction and the decision making process. Tegemeo's empirically based analytical work, and its objective stance in reporting and disseminating findings has over the past decade won the acceptance of government, the private sector, civil society, academia, and others interested in the performance of Kenya's agricultural sector.

Published 2011

Kindaruma Lane, off Ngong Road

P.O. Box 20498, 00200, Nairobi, Kenya

Tel: +254 20 2717818/76; Fax: +254 20 2717819

E-mail: egerton@tegemeo.org

URL: http://www.tegemeo.org

Tegemeo Institute acknowledges the resources support for its research programmes from key partners including the United States Agency for International Development (USAID), Michigan State University (MSU), and Egerton University, Njoro Kenya. Others include the World Bank, European Union, Department for International Development (DFID), and the Food and Agriculture Organization of the United Nations (FAO).

Abstract

This study examined trends in milk productivity and performance of the Kenyan smallholder dairy sector using a nationwide representative panel household data (2000-2010) and cross-sectional data collected in 2010 in the major milk producing areas. Descriptive statistics and gross margin analysis of the dairy enterprise were used to examine the performance of the dairy sector between zero and non-zero grazing systems, and across different milk sheds. The findings of the study showed a positive trend in milk productivity between 2000 and 2010. However, productivity was higher in higher potential areas and increased up the income quintiles, suggesting that dairy farming could be a preserve of the relatively better off households. Gross margin analysis showed that dairying is an economically viable enterprise in the short-run, with the non-zero grazing system having higher gross margins and therefore, a financial advantage. However, an example of zero grazing for farmers selling milk through the Githunguri farmers' cooperative society indicated that zero grazing dairying can perform well under conditions of collective marketing, good linkage to markets in terms of processing, access to production information, credit as well as other benefits. Greater commercialization of the dairy sub-sector and an increase in smallholder incomes will come from improved technologies that will make the existing resources more productive, as well as policies and actions that will deal with the seasonal intra-year variations in production which include creation of a strategic milk reserve, investment in processing of long life dairy products and investment in infrastructure such as roads and electricity.

Key words: Milk, smallholder dairy enterprise, variable costs, gross margin

Acknowledgments

Support for this research was provided by the Tegemeo Agricultural Policy Research and Analysis (TAPRA) Project between Tegemeo Institute/Egerton University and the Department of Agricultural Economics, Michigan State University. Financial support for the project was provided by the Kenya Mission of the United States Agency for International Development. We sincerely thank the Kenya National Bureau of Statistics (KNBS) for their support in sampling process and data collection.

Table of Contents

List of Tables

List of Figures

1. Background

Kenya's dairy industry is dynamic and plays an important economic and nutrition role in the lives of many people ranging from farmers to milk hawkers, processors, and consumers. Kenya has one of the largest dairy industries in sub-Saharan Africa. Though the last livestock census was conducted in 1966, the current official cattle population statistics come from the Ministry of Livestock and Development, through its field reports compiled by extension officials. The official statistics place the number of milking cattle at 3.8 million (Government of Kenya, 2008). A survey conducted by Smallholder Dairy Project (SDP) asserts that there are approximately 6.7 million dairy cattle in Kenya (SDP, 2005). The Food Agricultural Organization (FAO) on the other hand estimates a figure of 5.5 million milking animals (TechnoServe, 2008). In Africa, Kenya is the only country, after South Africa that produces enough milk for both domestic consumption and export. Sudan on the other hand is the largest producer of milk in the Common Market for Eastern and Southern Africa (COMESA), but it does not produce enough to satisfy both domestic and export markets.

The dairy industry is the single largest agricultural sub-sector in Kenya, larger even than tea (Muriuki et al. 2004). It contributes 14 percent of agricultural GDP and 3.5 percent of total GDP (Government of Kenya, 2008). The industry has grown tremendously since its liberalization in 1992. Liberalization led to a rapid growth of the informal milk trade that mainly consists of small-scale operators dealing in marketing of raw milk. At that time, there was an emergence of new institutional arrangements in milk collection, processing and marketing, which included hawkers, brokers, self-help groups, neighbours and business establishments like hotels (Karanja, 2003). The informal milk market controls an estimated 70 percent of the total milk marketed in Kenya (KDB 2009; Government of Kenya 2006). This sector is important and is driven by among other factors the traditional preferences for fresh raw milk and its relatively lower cost. Raw milk markets offer both higher prices to producers and lower prices to consumers but with several challenges relating to quality control and standards, and the associated health and safety concerns.

The informal milk market has in the past faced several challenges. This was because prior to policy change in 2004, informal vendors, including mobile milk traders and bar vendors, and

milk transporters, were not officially recognised under the old dairy policy. As a result, they were frequently harassed as powerful dairy market players sought to protect their interests and increase market share. There were also concerns over food safety and quality of milk sold by the informal sector players. The dairy policy at the time focused on promoting value addition and increasing the market share of pasteurized milk while attempting to address potential public health risks of consuming raw milk. However, since 2004, there has been a major change in policy and practice towards the informal milk market (Leksmono, C.et al 2006). The Dairy Policy now clearly acknowledges the role of small scale milk vendors (SSMVs) and contains specific measures to support them. These include: development of low-cost appropriate technologies, training on safe milk handling, provision of incentives for improved milk collection and handling systems, and establishment of a supportive certification system. While the Dairy Policy is still in progress, awaiting approval by parliament, there has been a proactive engagement by the Kenya Dairy Board in training and certification of SSMVs, in order to safeguard public health and assure quality of the raw milk (Leksmono, C. et al 2006).

This study examined the Kenya dairy sector through a synopsis of the trends in milk productivity over time, and the performance of the dairy enterprises at the farm level. Using both cross-sectional (2010) and panel data (2000-2010) collected from small scale farms in selected districts in Kenya. Findings from the study were presented using descriptive statistics and gross margin analysis of the dairy enterprise. The gross margin analysis sought to establish the economic viability of smallholder dairy production units. The specific objectives of the study were to examine milk productivity trends; assess variable costs of production and gross margin at the farm level for different grazing systems; highlight the constraints in the dairy industry; and, outline policy implications in relation to the socio-economic issues in milk production and marketing.

Section 2 of the paper provides a brief review of literature on the Kenyan dairy sector. Section 3 describes data and methods, while results are discussed in section 4. Summary and conclusions are presented in section 5, and policy recommendations are outlined in section 6.

2. Overview of the Kenyan Dairy Sector

Kenyans are amongst the highest milk consumers in the developing world, consuming an estimated 145 litres per person per year, more than five times milk consumption in other East African countries (SDP, 2005). Among all developing countries, only Mongolians and Mauritanians consume more milk per dollar earned than do Kenyans (ILRI, 2007). Kenyans consumed about 3 billion litres of milk in 2005 with conservative milk demand estimates suggesting an increase of milk consumption of between 3 and 4 percent per annum, which is largely driven by increases in population, urbanization and incomes. At that time, it was expected that milk consumption would rise to 3.5 billion litres by 2010 and 4.2 billion litres by the end of the Strategy for Revitalization Agriculture (SRA) plan period (Government of Kenya, 2006).

On the production side, Kenya is self-sufficient in milk. In 2005, the country produced approximately 3.5 billion litres of milk, against a consumption of about 3 billion litres. In addition, policies adopted by the government are expected to lead to significant increases in dairy production. For instance, the Kenya dairy policy change of 2004, which incorporated small-scale milk producers and traders into the milk value chain and liberalized informal milk markets, has led to an increase in the amount of marketed milk, number of licensed milk vendors and a boost in demand for milk, leading to benefits for Kenyan milk producers, vendors and consumers. As a result of this policy change, milk production was targeted to increase to 4.2 and 5 billion litres by 2010 and 2014, respectively (Government of Kenya, 2006). In 2009, dairy industry statistics by the Kenya Dairy Board estimated the national milk production at 4 billion litres.

Milk production in Kenya is predominantly by small scale farmers, who own one to three dairy animals, and produce about 80 percent of the milk in the country. Smallholder dairy production systems range from stall-fed cut-and-carry systems, supplemented with purchased concentrate feed, to free grazing on unimproved natural pasture in the more marginal areas. Upgraded dairy breeds tend to be kept in stall-feeding units, cross-bred cattle in semi-zero-grazing systems, and zebu cattle in free-grazing systems. The production systems are influenced by the agro climatic characteristics of the area, land productivity potential and prevalence of animal diseases. The

widespread adoption of dairy cattle in the country was stimulated by several interacting factors such as: the conducive policy and institutional environments provided by successive Governments; the presence of significant dairy populations (owned by settler farmers); a sub-tropical geography suitable for dairy cattle; and, smallholder communities who kept cattle and who had milk as an important part of their diet (Thorpe et al, 2000).

The dairy processing industry in Kenya comprises of large, medium and small scale processors. Until the 1990s, the Kenya Creameries Corporation (KCC) processed all the milk in Kenya, but its monopoly slowly decreased between 1993 and 1996 (Olok-Asobasi and Sserunjogi, 2001). Despite liberalization and restructuring of the dairy sector, political interventions, inefficient management and political rent-seeking behavior led to the collapse of KCC as a state monopoly in the 1990s. Consequently, the end of government monopoly status of KCC encouraged private sector participation through other large-scale processors. Many private processors joined the dairy business in 1992, and have increased greatly since 1999. According to the industry statistics by the Kenya Dairy Board, in 2010, there were an estimated 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars.

Over the last few years, milk processing in Kenya has been dominated by three major processors, namely, the New KCC, Brookside Dairy Limited and Githunguri Dairy Farmers Cooperative and Processors. The three processors command a large market share, in an industry with about 27 processors. Brookside and Githunguri Dairies process 400,000 litres and 150,000 litres a day, respectively, during the high season. The New KCC on the other hand processes 450,000 litres of milk a day during the high season, and controls 37 percent of the market share. New KCC runs 11 cooling plants, 11 factories and 12 sale depots nationwide, and has been increasing its processing capacity largely through increased milk delivery resulting from goodwill and loyalty of farmers. Brookside too has been expanding through the acquisition of other medium and small processing plants, such as the merger with Spin Knit Dairy (Standard newspaper, published on 23/03/2010). Following this merger, the combined total installed capacity stood at 600,000 litres per day, up from 450,000 litres previously handled by the processor. Currently, Brookside Dairy has an installed processing capacity of 750,000 litres per day (Brookside Dairy website).

Industry statistics by the Kenya Dairy Board show that Brookside was the biggest processor in the month of December 2009, but was in January 2010 dislodged by New KCC, which was processing about 620,000 litres of milk. In 2010, Brookside had a 40 percent share of the Kenyan dairy market, with milk sourced from approximately 120,000 suppliers. Seven percent of these suppliers were commercial farmers and the rest are small scale producers (Business Daily posted Friday, February 19, 2010). Githunguri Dairy Farmers Cooperative, on the hand, has an average installed processing capacity of 170,000 litres per day (Githunguri Dairy Farmers Cooperative website).

Although Kenya's dairy sector has a significant contribution to the national economy, household incomes and food security, the industry faces a number of technical, economic and institutional problems in milk production, processing and marketing (Karanja, 2003). These constraints affect the ability of the sector to participate and compete in the domestic and regional markets.

Specifically, some of the main constraints to increased milk production in Kenya have been identified as seasonality in production, inadequate quantity and quality of feed, including limited use of manufactured cattle feeds, and lack of good quality animal husbandry and farming practices. Poor access to breeding, animal health and credit services and high cost of artificial insemination (AI) service are other constraining factors. In some areas, dairy producers are faced with the problem of poor infrastructure (roads, electricity), inadequate milk collection and marketing system, poor interaction and priority setting between research, extension and training, and limited farmers' involvement in the output market, hence reducing the incentives to increase milk production (SDP, 2005).

Milk processing and marketing on the other hand is limited by several factors. Primary marketing faces infrastructure bottlenecks caused by poor road networks and lack of appropriate cooling and storage facilities. The poor road infrastructure in the small-scale production areas affects the transport of milk from farms to the collection centres, and subsequently from the collection centres to the processors. The lack of electricity in most areas has limited the establishment of cooling plants. As a result, particularly during the flush period of March to June, there is surplus milk that cannot be absorbed in the domestic market. In addition, low and irregular producer payments that coincide with the flush period could be largely responsible for

the lack of investment in productivity enhancing inputs in the dairy industry. Over the last few years, the cost of electricity has been rising with the increase in fuel prices. This increase is likely to impact on the processors' cost of production and hence the consumer price for processed dairy products. On the other hand, majority of the processors operate below capacity, and they face competition from a fluid, cash-based informal market. Seasonal fluctuations in quantity of milk delivered and farm gate prices do also affect the profit margins.

Though Kenya shares some of the constraints with South Africa, South Africa still remains a large competitor to the Kenya dairy products. Both countries are constrained by seasonality in production, with an upsurge in milk production during the rainy months. Similarly, the market share of both countries' dairy sector is dominated by a few major players. As previously mentioned, milk processing in Kenya has been dominated by three major processors who account for more than 85 percent of the market. The South African dairy industry is dominated by five major milk buyers and almost 50% of the dairy market is controlled by only two buyers (Scholtz and Grobler, 2009). These milk buyers are only involved in the secondary industry and not in the primary industry. Among them, the three major players include Nestle, Parmalat & Danone. High cost of inputs such as feeds and fertilizer is also common in both countries.

There are also various differences in the dairy sectors of the two countries. The average daily milk production in Kenya is 8-10 litres per cow, whereas in South Africa, in 2007, the national average milk production per cow was 4 590 kg, approximately 12.7 litres in daily production (Theron & Mostert, 2008). The South African dairy industry is more capital intensive, highly specialised and with fewer producers who are managing larger dairy operations. On the other hand, the Kenyan dairy sector is dominated by small scale producers. About 89 percent of milk in South Africa is marketed through formal channels, and almost all the fresh milk sold is pasteurised. In Kenya, only about 30 percent of the milk is marketed through the formal channels. These characteristics give South Africa a competitive edge with regard to dairy processing and marketing, hence capturing a larger share of the export market.

2.1 Government Interventions

The Kenyan government over the past decade has recognized the challenges facing the dairy industry. With the support from the private sector and donor agencies, various interventions have been spearheaded with the intention of analyzing the factors constraining the competitiveness of smallholder dairy farmers and policies and institutions affecting the dairy sub-sector, among others. These interventions include: the Smallholder Dairy Project jointly implemented by the Ministry of Livestock Development (MoLD), the Kenya Agricultural Research Institute (KARI) and the International Livestock Research Institute (ILRI), with primary funding from the UK Department for International Development (DFID); the USAID (United States Agency for International Development) Kenya Dairy Sector Competitiveness Program (KDSCP) which is a 5-year effort to improve Kenya's dairy industry competitiveness, and implemented by Land O'Lakes, Inc., with financial and technical support from USAID; IFAD funded Smallholder Dairy Commercialization Programme (SDCP) which is implemented by the Ministry of Livestock Development; East African Dairy Development (EADD) Programme funded by the Bill and Melinda Gates Foundation and being implemented by the Heifer Project International, TechnoServe and ILRI; Heifer International dairy project in parts of the Rift Valley and Central Province through gifts of income-producing animals and training; and, the Kenya Dairy Project (KDP) funded by private donors and implemented by Technoserve Inc. in Nyala in Nyandarua North, Sabatia Dairy Farmers Cooperative in Eldama Ravine, Ndumberi Dairy Farmers in Kiambu and Muki Dairy in North Kinangop (Land O' Lakes, 2008).

The government of Kenya has in addition since 2003 put in place several other measures to revive the dairy industry. These measures that led to the improvement in milk production and marketing included: restructuring and capacity building of Kenya Dairy Board; revival and strengthening of New KCC and other farmer organizations like the Agricultural Finance Cooperation (AFC) and cooperatives; review of dairy policies and regulations; improved milk producer prices and timely payment to milk producers by the New KCC; encouragement of development partners and private sector to mobilize more resources to the industry; monitoring of dairy imports; and improved coordination and collaborative ventures among stakeholders that created synergies and better use of resources (Kenya Dairy Board website, accessed in June

2010). These interventions resulted to strengthened producer organizations which were able to collectively market dairy produce and access extension services, among others things. Consequently, production and marketing of dairy produce increased with the annual milk production rising from 2.8 billion litres in 2002 to 4 billion litres in 2009 and intakes by processors rising from 143.5 million litres in 2002 to 407 million in 2009, representing a 180% increase (Kenya Dairy Board website, accessed in June 2010).

The review of import and export procedures for dairy produce as a legislative measure on the other hand led to diminished imports and a sharp rise in exports. The quantity of milk and milk products exported rose from 0.1 million Kg in 2001 to 10.9 million Kg in 2008, but due to drought, export figures dropped to 5 million Kg in 2009. Imports on the other hand declined from 5.2 million Kg in 2001 to 3.4 million Kg in the same period (Kenya Dairy Board website, accessed in June 2010). Disturbances in early 2008 arising from the post election violence however disrupted dairying activities in most parts of the Rift Valley (which is a major milk producing area) leading to a drop in milk production and marketed volume in the affected areas. Moreover, the country faced a severe drought in 2009 causing scarcity of animal feed and water which led to a further drop in milk production. Due to this shortage, the local dairy processing plants were unable to sustain the previously acquired export markets.

On the contrary, with the onset of the rains in late 2009 (October/November), there was an upsurge in milk production leading to increased milk intakes by the formal sector. This sudden increase in production overstretched the handling capacities of the major milk processors. Daily intakes by processors rose sharply from an average of 0.8 million litres in May 2009 to 1.7 million litres by January 2010 (Kenya Dairy Board website, June 2010). Consequently, the government of Kenya proposed various short, medium and long term interventions to deal with increased milk production in future. The short term interventions included availing a grant of Ksh 300 million to the Kenya Dairy Board (KDB) to buy the excess processed milk from the processors. The medium term interventions included financial support to the New KCC to refurbish and commission a UHT plant in Eldoret and a condensed milk plant in Naivasha, as well as procure, install and commission an additional milk drier. In the long term, the government plans to incorporate milk powder into the National Food Strategic Reserve to

improve uptake of excess milk which can then be offloaded into the market during times of scarcity; expand dairy markets away from the traditional markets; enhance quality production of milk and milk products; upscale the existing school milk programme; and create a Dairy Development Fund to provide resources for necessary interventions in the dairy industry including marketing, surveillance, product development and compliance to standards.

The private sector has also taken steps to deal with upsurges in milk production. For instance, in February 2011, Githunguri Dairy launched a UHT milk production unit in a bid to increase its market share. It is expected that the UHT factory will enable the dairy to absorb more milk during periods of glut and increase exports of long-life milk to markets like South Sudan, Rwanda and Mauritius.

3. Data and Methods

3.1 Data and Sampling

The data for the study was obtained from three sources: (i) a longitudinal rural household survey; (ii) a cross-section survey of dairy farmers; (iii) and, key informant interviews.

The rural household surveys were conducted in 1999/00, 2003/04, 2006/07 and 2009/10 cropping years[1] by Tegemeo Institute of Egerton University, with support from Michigan State University under the Tegemeo Agricultural Monitoring and Policy Analysis (TAMPA) and the Tegemeo Agricultural Policy Research and Analysis Program (TAPRA) projects. These surveys covered 24 administrative districts, 39 divisions and about 120 villages. The districts were purposively chosen to represent the broad range of agricultural production systems and agro-ecological/climatic areas in Kenya. These areas were classified into eight agro-regional zones, based on agro-ecological zones and population density. Next, all non-urban divisions in the selected districts were assigned to one or more agro-regional zones based on agronomic information from secondary data. Third, proportional to population across the zones, divisions were selected from each zone. Fourth, within each division, villages and households in that order were randomly selected.

[1] These cropping years are hereafter referred to as 2000, 2004, 2007, and 2010, respectively.

In the initial survey of 1997, a total of 1,578 households were selected in the 24 districts within the seven agriculturally-oriented provinces of the country and also in Turkana and Garissa districts. The sample excluded large farms with over 50 acres and two pastoral areas. From 2004, households in Turkana and Garissa districts were not interviewed. This analysis is based on 1,245 households which formed a balanced panel for four cropping years. The distribution of the sampled districts across various agro-regional zones is presented in Table 3.1 The agro-regional zones represent areas with different agricultural potential. The Lowlands are the least productive, while Western Transitional, Western Highlands and Marginal Rain Shadow are of medium potential and Central highlands and High potential maize zone have the highest agricultural potential.

Table 3.1: Distribution of sampled households by districts and agro-regional zones

Agro-regional zone	Districts	No. of households
Coastal Lowlands	Kilifi, Kwale	74
Eastern Lowlands	Machakos, Mwingi, Makueni, Kitui, Taita-Taveta	141
Western Lowlands	Kisumu, Siaya	149
Western Transitional	Bungoma (lower elevation), Kakamega (lower elevation)	146
Western Highlands	Vihiga, Kisii	128
Central Highlands	Nyeri, Muranga, Meru	241
High-Potential Maize Zone	Kakamega (upper elevation), Bungoma (upper elevation) Trans Nzoia, Uasin Gishu, Bomet, Nakuru, Narok	332
Marginal Rain Shadow	Laikipia	374
Overall sample		**1,245**

The cross sectional survey was conducted between January and June, 2010. The information collected included farm-level dairy enterprise costs and revenues, production and sale of milk, and demographic characteristics of the household head. This information was collected from 106 small-scale dairy farmers across five milk sheds. The sampling procedure was multistage. First, five districts were randomly selected from milk producing districts. The sampled milk sheds include: Trans Nzoia, Kinangop, Nyeri, Githunguri, and Kericho. Second, from each milk shed, active dairy farmers were randomly selected through their dairy cooperative societies. The distribution of the sample is indicated in Table 3.2.

Table 3.2: Distribution of households in the sample by milk shed

Milk Shed	Number of households	Percent
Githunguri	10	9.4
Kinangop	22	20.8
Trans-Nzoia	24	22.6
Nyeri	26	24.5
Kericho	24	22.6
Total	**106**	**100.0**

Key informant interviews were also conducted. A formal survey checklist was used to collect information from managers of dairy processing plants and officials from the Ministry of Agriculture and the Kenya Dairy Board. The information collected included production and marketing constraints as well as opportunities and perceptions on the performance of the dairy sector.

3.2 Methods of Analysis

Descriptive and gross margin analyses were used to address the key objectives in this study. Using the panel data, trends in milk production and productivity as well as ownership of dairy cows across different agro-regional zones and income groups were described. In addition, the cross sectional data collected from dairy farmers was used to describe the current milk production systems, productivity and commercialization of raw milk. Economic analysis at the farm level was based on gross margin analysis, in which the gross margin serves as the unit of analysis in evaluating the economic performance of an enterprise. Gross margin is defined as the difference between the value of an enterprise's gross output and variable costs of the enterprise, which vary with the size of production.

4. Results and Discussion

4.1 Milk Production and Productivity Growth: Panel Data Analysis (2000-2010)

4.1.1 Ownership of Cows by Households with a Dairy Enterprise

Rearing of livestock is a common practice among farmers in Kenya. The dairy breeds kept in the country range from local breeds such as the zebu, improved breeds that include crosses of local and pure breeds, and pure grade breeds of Jersey, Friesian, Guernsey and Ayrshire. The percentage of households that kept cows, improved or local, by the gender of the head of household between 2000 and 2010 is shown in Table 4.1. Across the years, a higher percentage of male-headed households kept improved cows compared to their female counterparts. On the other hand, more female-headed households kept local animals, indicating that they had less access to improved dairy breeds and perhaps dairy technologies in general. This finding is consistent with Baltenweck and Staal (2000), who found that female-headed households were more likely to have less access to information on new dairy technologies. Overall, the percentage of households keeping improved animals increased over the years.

Table 4.1: Percentage of households keeping cows by gender of the head of household (2000-2010)

Gender of household head	Percentage of households keeping cows							
	2000		2004		2007		2010	
	local	improved	local	improved	local	improved	local	improved
Male	28.1	50.0	27.9	57.9	31.4	56.6	28.9	56.8
Female	39.0	34.9	34.9	42.9	34.5	39.3	31.6	40.6
Sample	**29.4**	**48.2**	**29.3**	**54.8**	**32.1**	**52.6**	**29.7**	**52.4**

Across the agro-regional zones, there was variation in the percentage of households that kept different types of cows (Table 4.2). More than 80 percent and over 70 percent of the households in the Central Highlands and High Potential Maize zones, respectively, kept improved cows. On the other hand, over 60 percent of the households in Western Lowlands and Western Transitional zones kept local animals. These zones have a less favorable environment for improved animals and hence this trend.

Table 4.2: Percentage of households that kept improved or local cattle by agro-regional zones (2000-2010)

	Percentage of households keeping cows							
	2000		2004		2007		2010	
Agro-regional zone	local	improved	local	improved	local	improved	local	improved
Coastal Lowlands	13.5	0.0	21.6	6.8	18.9	5.4	27.0	5.4
Eastern Lowlands	56.7	25.5	40.4	41.8	52.5	34.8	44.7	30.5
Western Lowlands	57.7	2.7	61.1	3.4	68.5	0.7	70.5	3.4
Western Transitional	56.8	25.3	61.6	28.8	67.8	28.1	50.7	38.4
High Potential Maize Zone	**17.5**	**72.0**	**17.2**	**75.6**	**18.7**	**74.4**	**15.1**	**75.9**
Western Highlands	27.3	50.0	36.7	63.3	28.9	64.1	35.2	53.9
Central Highlands	**2.1**	**83.0**	**0.4**	**88.8**	**1.7**	**85.5**	**1.7**	**84.2**
Marginal Rain Shadow	26.5	58.8	17.6	64.7	23.5	70.6	26.5	61.8
Average	29.4	48.2	29.3	54.5	32.1	52.5	29.7	52.4

The trend in the total number of local and improved cows kept by households between 2000 and 2010 is presented in Figure 4.1. There were nearly a constant number of improved cows, but a decline was observed in 2010, which is attributed to the prolonged drought in 2009. The number of local cows fluctuated between 2000 and 2010.

The average number of improved and local cows owned by households was different across the agro-regional zones over the last decade (Table 4.3). The High Potential Maize Zone had the largest number of improved cows followed by the Marginal Rain Shadow, while Coastal Lowlands had the largest number of local cows. The lowlands which represent areas of lower agricultural potential have relatively larger herd sizes of local than improved cows. Generally, a higher proportion of households in the higher potential agricultural areas compared to those in the lower potential areas kept improved cows and had larger herd sizes.

Across income quintiles, the number of improved cows increased up the quintiles, but there is no clear pattern for the local cows. However, the difference in herd size for local cows across quintiles is less pronounced compared to that for improved cows. While households in the highest quintile had nearly four times more heads of improved cows than the lowest quintile, they had about

Figure 4.1: Trends in number of cows owned

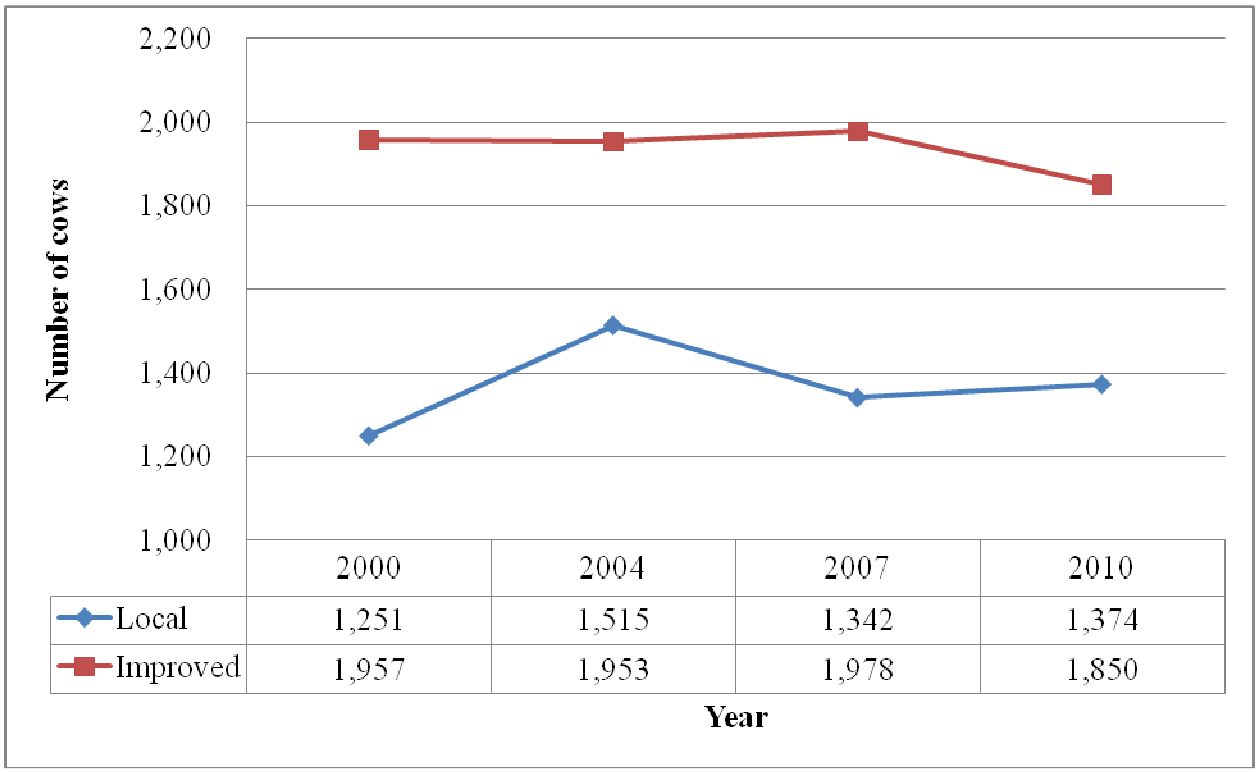


Table 4.3 Average number of cows kept by households by type and agro-regional zone

	Improved cows				Local cows			
Agro-regional zones	**2000**	**2004**	**2007**	**2010**	**2000**	**2004**	**2007**	**2010**
Coastal Lowlands	0.1	0.7	0.2	0.2	3.2	9.6	4.7	4.0
Eastern Lowlands	1.0	1.2	1.1	0.8	2.5	1.7	1.9	1.7
Western Lowlands	0.2	0.1	0.0	0.1	4.6	4.7	3.5	4.1
Western Transitional	1.3	1.0	1.0	1.3	3.7	2.8	2.8	1.6
High Potential Maize Zone	6.8	6.0	6.0	5.4	3.2	1.6	2.1	2.2
Western Highlands	2.1	1.8	1.8	1.5	1.2	1.0	0.8	1.1
Central Highlands	3.3	2.5	2.4	2.2	0.1	0.0	0.0	0.0
Marginal Rain Shadow	4.2	3.7	4.1	3.1	1.8	1.0	1.1	1.8
Average	**3.2**	**2.7**	**2.6**	**2.4**	**2.5**	**2.2**	**1.9**	**1.9**

two times more heads of local cows compared to their lowest quintile counterparts. This clearly indicates that well to do households keep more animals, particularly the improved breeds as they can afford to purchase the cows and manage such an enterprise.

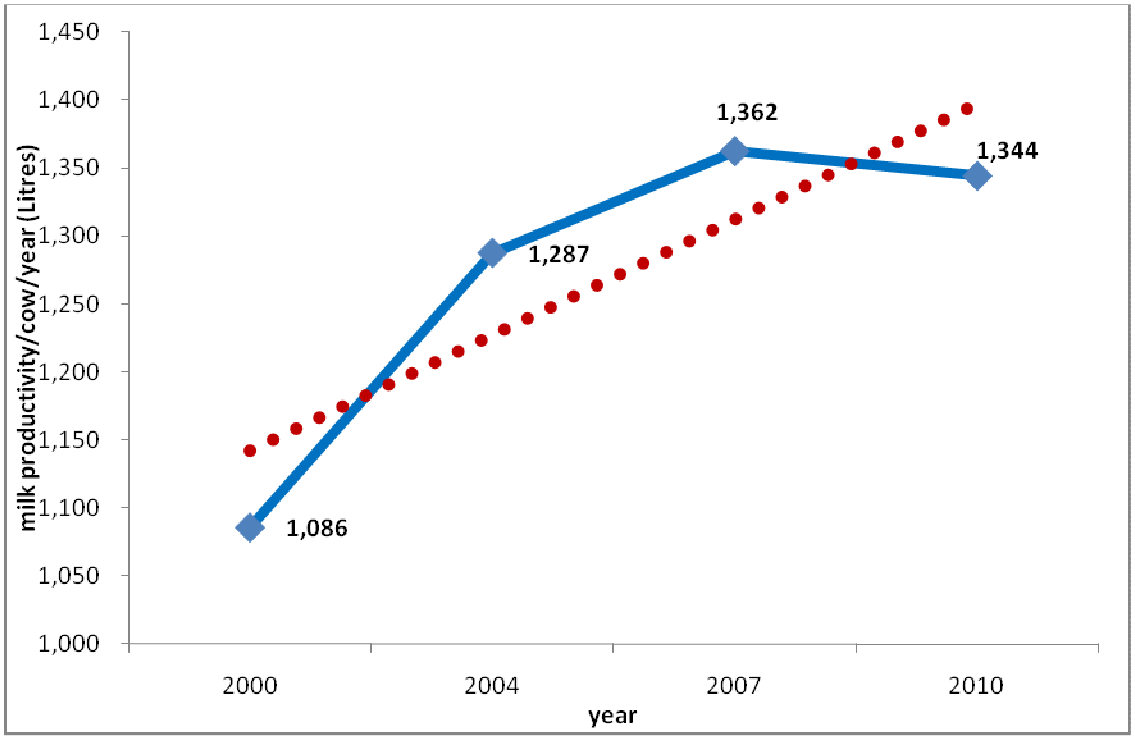
Table 4.4 Average number of cows owned by households by income group

Income quintile	Improved cows				Local cows			
	2000	**2004**	**2007**	**2010**	**2000**	**2004**	**2007**	**2010**
Lowest	1.7	1.2	1.0	1.0	3.3	1.5	1.6	2.7
2	2.0	1.8	1.5	1.5	1.6	1.4	1.3	1.3
3	2.8	2.3	2.2	2.1	1.7	1.8	1.5	1.8
4	3.3	3.4	3.9	2.8	2.7	1.7	1.6	1.7
Highest	5.9	4.6	4.6	4.2	3.3	4.5	3.6	1.9
Average	**3.2**	**2.7**	**2.6**	**2.4**	**2.5**	**2.2**	**1.9**	**1.9**

4.1.2 Milk Productivity Trends (2000-2010)

Over the last decade, milk productivity growth has been positive. The increase in productivity may be attributed to a number of factors such as improved animal husbandry practices and veterinary care, better quality feeds, and adoption of more intensive grazing systems and improved cow breeds. Using panel data, results in Figure 4.2 show a general positive trend in milk productivity per cow per year over the last decade. Milk productivity was, however, slightly

Figure 4.2: Trend in milk productivity (2000-2010)



lower in 2010 compared to 2007 due the prolonged drought in most of 2008/2009 and 2009/2010 cropping years. The positive trend in milk productivity can be partly explained by increased adoption of improved animals, among other factors. Previous results show that overall the percentage of households keeping improved animals increased over the panel years.

Milk productivity varied across the different agro-regional zones (Table 4.4). The highest level of productivity was achieved in the Central Highlands followed by the High Potential Maize Zone and was lowest in the Western Lowlands. These results are consistent with the finding that a higher proportion of households in the higher potential agricultural areas compared to those in the lower potential areas kept improved cows and had larger herd sizes. The relatively higher productivity level as compared to other agro-regional zones can also be attributed to choice and intensity of the grazing system as well as the favorable climate for rearing dairy animals. Both Central Highlands and the High Potential Maize zone have an annual rainfall of about 750mm.

Within a cropping year, seasonality in milk production poses a major challenge in milk processing and marketing. For instance, in 2009, the country faced a severe drought that affected most parts of the country with the dairy sub-sector suffering due to scarcity of animal feed and water. This led to a sharp drop in milk production and milk intake by processors. However, the onset of the rainy season towards the end of the year (October/November, 2009) brought about an upsurge in milk production arising from the improved availability of fodder and water.

Table 4.4: Milk productivity growth by agro-regional zone

	Milk productivity (litres/cow/year)			
Agro-regional zone	**2000**	**2004**	**2007**	**2010**
Coastal Lowlands	418.4	206.7	700.5	606.7
Eastern Lowlands	864.3	785.1	889.9	852.9
Western Lowlands	**371.8**	**359.4**	**365.0**	**498.5**
Western Transitional	661.9	811.6	1019.5	940.2
High Potential Maize Zone	968.6	1291.6	1679.9	1602.6
Western Highlands	1005.5	1070.9	836.1	898.3
Central Highlands	**1973.9**	**2233.7**	**1985.2**	**2035.7**
Marginal Rain Shadow	617.9	1480.4	1433.6	1482.3
Average	**1085.8**	**1287.5**	**1362.2**	**1344.0**

This sudden increase in production overstretched the handling capacities of the major milk processors. Consequently, some of the milk produced went to waste as both formal and informal markets could not take up all the milk. The trend in milk production per cow per month between June 2009 and May 2010 is presented in Figure 4.3. Productivity was highest in the month of February, 2010, where on average a cow produced 212 litres of milk. The high productivity relative to the rest of the months is attributed to the availability of pastures and water. On the other hand, the lowest productivity of 181 litres per cow was recorded in September 2009, just before the onset of the rainy season in October/November 2009.

Between June 2009 and May 2010, milk productivity was highest in the High Potential maize Zone (297 litres/cow), followed by Central Highlands (233 litres/cow), while Western and Eastern Lowlands had the lowest milk productivity at 67 and 91 litres/cow, respectively.

Milk productivity also varied across income groups. Table 4.6 shows a general positive trend in milk production per cow per year over the last decade for farmers in different income groups. As expected, farmers in the highest income group had the highest level of milk productivity in all the years from 2000 to 2010, and productivity increased up the income quintiles. This suggests that dairy farming could be a preserve of the relatively better off households, and could be attributed to the fact that these households had the highest number of cows across the years. In addition, the better off farmers have the capacity to: (i) purchase improved breeds of cows and adequate animal feeds of good quality; (ii) and, finance better and more improved animal husbandry practices.

Figure 4.3: Seasonality in milk productivity (litres per cow per month)

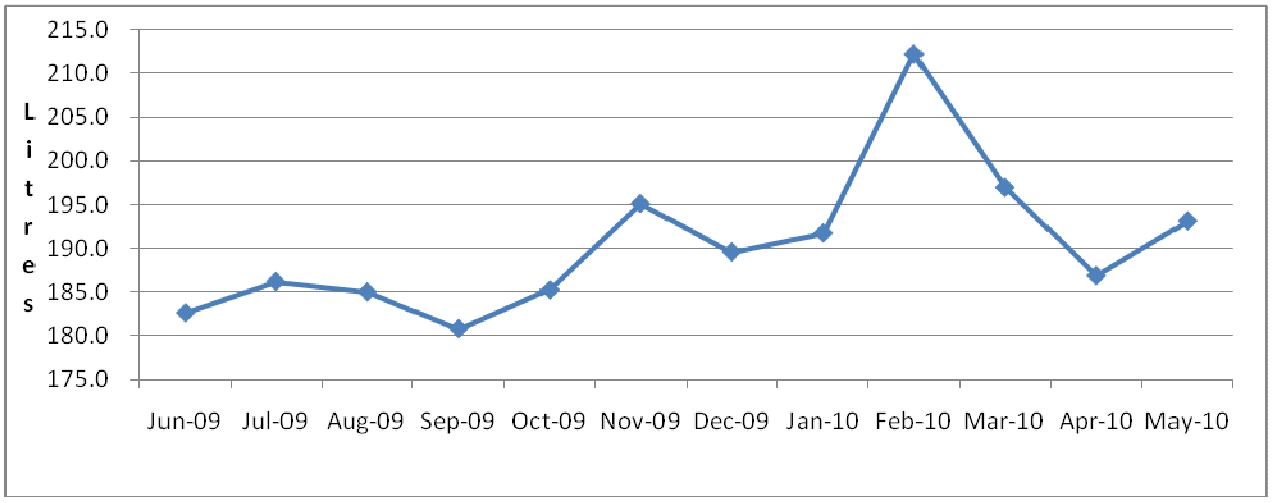


Table 4.6: Milk productivity growth for different income groups

	Milk productivity (litres/cow/year)			
Quintiles of income	**2000**	**2004**	**2007**	**2010**
Lowest	361.4	440.6	478.1	601.0
2	642.6	807.9	911.5	1000.4
3	1016.1	1205.6	1204.7	1144.2
4	1244.4	1395.2	1642.7	1496.5
Highest	**1641.9**	**1974.4**	**1931.6**	**1964.4**
Average	**1085.8**	**1287.5**	**1362.2**	**1344.0**

4.1.3 Milk Marketing

This sub-section presents descriptive results on the participation of households in the milk market in terms of proportion of households that sold milk and contribution of revenue from sale of milk to a household's total income.

The proportions of households that sold milk by agro-regional zone, gender of the household head and quintiles of income are presented in Table 4.7. The percentage of households that sold milk increased from 51 percent in 2000 to 57 percent in 2010. Across the agro-regional zones, over 65 percent of households in the Central Highlands and the High Potential Maize Zones sold milk between 2000 and 2010. In the Marginal Rain Shadow zone, the percentage of households

selling milk varied widely across the years, being highest in 2007 (82 %), and lowest in 2010 (44 %), which may be attributed the uncertain rainfall patterns experienced in this area. The higher

Table 4.7: Percentage of households selling milk by agro-region, gender of head and income quintile

Agro-regional zones	2000	2004	2007	2010
Coastal Lowlands	6.8	9.5	5.4	5.4
Eastern Lowlands	39.0	45.4	43.3	42.6
Western Lowlands	19.5	17.4	20.1	22.1
Western Transitional	50.3	55.9	58.6	64.8
High Potential Maize Zone	**65.3**	**67.1**	**72.2**	**73.4**
Western Highlands	48.4	46.9	48.4	56.3
Central Highlands	**69.7**	**69.7**	**71.8**	**76.3**
Marginal Rain Shadow	**58.8**	**70.6**	**82.4**	**44.1**
Sample average	50.5	52.5	54.9	56.7
Gender of Head				
Male	51.0	53.8	57.9	60.6
Female	46.6	46.6	45.0	46.1
Sample average	50.5	52.4	54.9	56.7
Income quintile				
Lowest	33.9	25.7	20.0	25.3
2	41.4	50.6	47.4	48.6
3	50.0	52.4	57.5	62.7
4	57.4	62.7	72.3	69.1
Highest	69.8	70.6	76.6	77.4
Sample average	50.5	52.5	54.9	56.7

proportion of households selling milk in these three zones was consistent with the larger herd sizes of improved cows.

While the percentage of male headed households that sold milk rose from 51 percent to 61 percent between 2000 and 2010, the proportion of female headed households that sold milk remained fairly constant at 46 percent. Additionally, a higher percentage of male headed households than female headed households sold milk. As reported earlier, fewer female headed households kept improved animals. Consequently, milk production and marketable surplus would be expected to be lower. The proportion of households that sold milk increased up the income quintiles.

The proportion of milk sold by agro-regional zone and quintiles of income is presented in Table 4.8. Overall, the proportion of milk sold increased from 40 percent in 2000 to 62 percent in 2010. It was relatively higher in the High Potential Maize Zone, Central Highlands and Marginal Rain Shadow, which had a higher proportion of households selling milk and larger heads of improved cows. The proportion of milk sold in the Coastal Lowlands was also high, mainly obtained from the local cows. Also, the proportion of milk sold increased up the income quintiles.

Table 4.8: Proportion of milk sold by agro-regional zone and income quintile

Agro-regional zones	**2000**	**2004**	**2007**	**2010**
Coastal Lowlands	45.4	36.8	48.8	60.6
Eastern Lowlands	30.6	33.8	59.3	54.7
Western Lowlands	18.0	18.4	47.6	41.9
Western Transitional	41.9	35.3	56.4	55.5
High Potential Maize Zone	45.8	41.4	56.1	62.8
Western Highlands	35.0	27.2	53.7	52.5
Central Highlands	45.7	45.2	61.3	73.4
Marginal Rain Shadow	37.4	48.1	59.2	73.4
Sample average	39.8	37.4	57.2	62.1
Income quintile				
Lowest	33.8	23.4	51.7	60.3
2	38.3	34.9	53.7	58.3
3	38.0	38.2	56.6	59.6
4	40.2	40.1	57.6	62.5
Highest	45.6	43.5	61.0	66.6
Sample average	39.8	37.4	57.2	62.1

The contribution of revenue from sale of milk to total household income averaged 8 percent across the 2000-2010 period (Table 4.9). On average, contribution of revenue from milk sales was highest in the High Potential Maize zone, followed by Central Highlands and Marginal Rain Shadow. In these zones, a higher proportion of households kept improved cows and sold milk, and the households had larger herd sizes, and recorded higher milk productivity. Therefore, while dairy production is practiced by many households, most of them produced milk mainly for home consumption.

Table 4.9: Contribution of revenue from sale of milk to household's total income by agro-regional zones (2000-2010)

	Contribution of revenue from sale of milk			
Agro-regional zone	**2000**	**2004**	**2007**	**2010**
Coastal Lowlands	0.7	1.7	0.7	1.2
Eastern Lowlands	4.0	5.3	5.1	4.2
Western Lowlands	3.0	5.1	1.3	2.0
Western Transitional	5.8	7.9	6.8	7.8
High Potential Maize Zone	12.5	11.0	11.4	18.5
Western Highlands	5.3	7.3	5.8	7.3
Central Highlands	9.7	10.4	9.7	13.1
Marginal Rain Shadow	5.9	17.0	13.7	8.4
Total	**7.4**	**8.4**	**7.5**	**10.2**

4.2 Performance of the Dairy Enterprise: Cross Sectional Data

4.2.1 Characteristics of Households with Dairy Enterprises

The sample from the cross sectional survey had 106 smallholder households with a dairy enterprise, and not owning more than six dairy cows. On average, small scale dairy farmers in Kenya keep two to three cows. In this study, farmers who owned more than six cows were consider medium to large scale. Eighty eight (88) percent of these households were male headed. Education level of the household head varied; 38 percent had secondary education, 39 percent primary education, 8 percent had no formal education and only 5 percent had acquired a university degree. The main occupation of the household head was reported to be dairy farming by 37 percent of the households, whereas crop farming was reported by 32 percent of the households. Casual labour was reported as a main occupation by only 3 percent of the household heads. The mean age of the household head was 49 years and the average years of experience in dairy farming was 15. The average land holding was 4.4 acres and an average of 1.9 acres of land was allocated to grazing and growing fodder crops.

The dairy production systems practiced in Kenya can be divided into four broad categories namely zero grazing, semi-zero grazing, tethering and open grazing. Of the households sampled, 43 percent were practicing zero grazing, 32 percent open grazing, 10 percent tethering and 15 percent semi-zero grazing. The zero grazing system is a more intensively managed system and

cows are fed on rations that are relatively high in concentrates and stored forages. Tethering and open grazing are more pasture-based systems, which are the primary production systems in several dairy producing units in the country. The choice of the feeding system is normally motivated by a desire to optimize the limiting resource. For example, in areas of high population density, land tends to be the limiting factor whereas in open grazing, labour is the limiting factor. In semi-zero grazing, producers use a combination of zero and open grazing systems, which is appealing in that it reduces costs, but still allows the feeding of concentrates to improve milk production levels.

The selection of a production system is dependent on the genotype of the cattle (improved or local), the major products or objectives of production, the geographical region (climate and disease prevalence), and the socioeconomic characteristics of the producer. The latter include availability of land and labour, and the affordability of external inputs which are required in varying intensities across the different production systems.

4.2.2 Farm Level Performance of the Dairy Enterprises

Performance of the dairy enterprises at the farm level is described through an assessment of the variable cost structure and an estimation of the gross margin. The indicators used to describe the current status of the smallholder dairy enterprise in Kenya across different grazing systems are outlined in Table 4.10. The average number of dairy cows and lactating cows kept by households is 3 and 2, respectively, across the sample. In the first half of 2010, average milk production was estimated at 531 litres/ month. The average production per month was, however, higher in the zero grazing system. As a result of the intensive nature of the zero grazing systems, the average cost of labour per lactating animals was Ksh 745, compared to Ksh 705 in the non-zero grazing system.

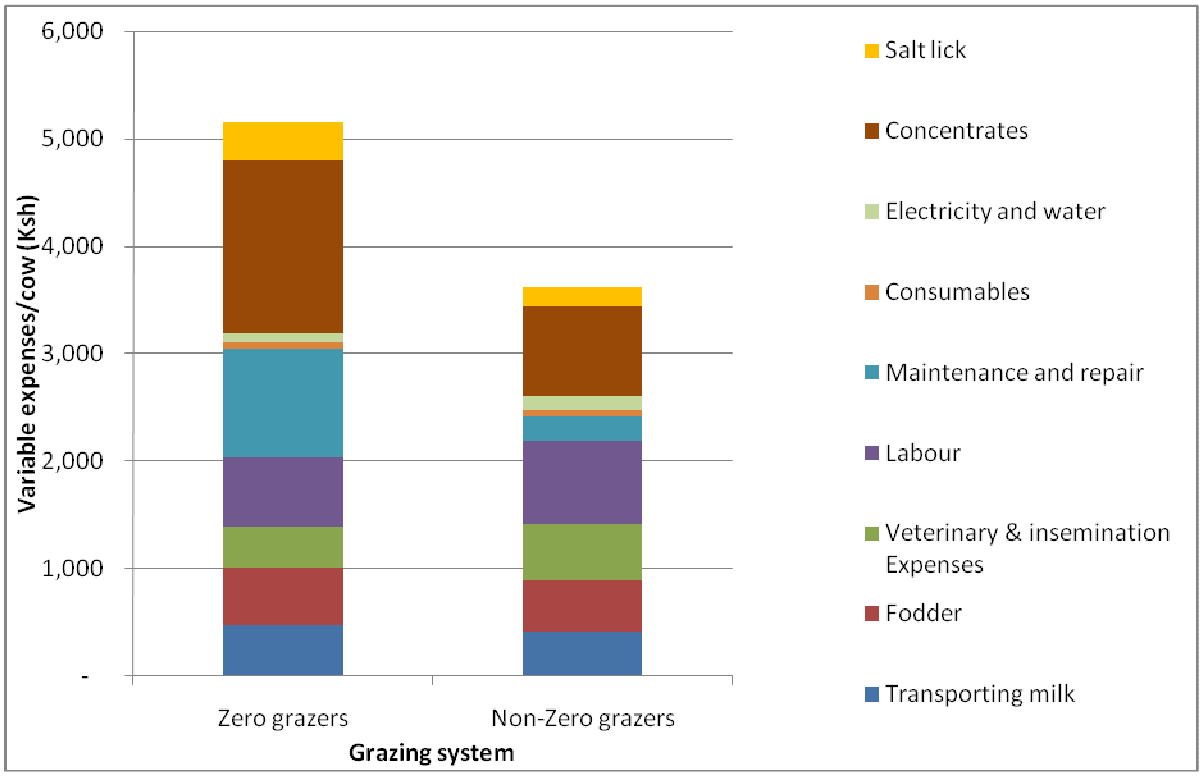
Table 4.10: Indicators describing the dairy enterprises by type of grazing system

Indicator	Overall	Zero-grazing	Non-zero grazing
Average no. of dairy cows	3	3	3
Average no. of lactating cows	2	2	2
Average milk yield, litres/lactating cow/month	411	436	393
Land input (acres/dairy animal)	1.9	1.3	2.3
Labour cost/ lactating cow/month	723	745	705

4.2.3 Cost Structure of the Dairy Enterprises

Data collected on various components of the variable costs of production was classified into various categories for ease of analysis (Figure 4.4). Most of the enterprise variable costs such as those for bought-in concentrates and fodder, salt lick and minerals, maintenance and repairs, consumables (fuel and milking jelly), water and electricity, veterinary and insemination, hired labour, and milk transportation were calculated on the basis of the market prices. The cost of own farm-produced fodder was calculated using the cost of hired labour and purchased inputs used in its production. The opportunity costs for own labour, land and capital as well as fixed costs associated with dairy enterprises are not included in the analysis. Purchase of concentrates formed the largest cost component among households practicing zero grazing and non-zero grazing systems (Figure 4.4). This was followed by the cost of maintenance and repairs in the zero grazing system, and labour in the non-zero grazing system. Unlike in the pure zero grazing system where the cows are confined, there is minimal or no confinement in the non-zero grazing system hence more labour requirements.

Figure 4.4: Cost structure of the variable costs



4.2.4 Gross Margin Analysis

Gross margin refers to the total income derived from an enterprise less the variable costs incurred in the enterprise. It enables producers to evaluate their existing enterprise performance, and for those who are contemplating investing in a new enterprise, it provides a guide to estimating the viability of the contemplated investment.

Results of the gross margin analysis for all the smallholder dairy farmers interviewed in selected areas in Kenya and categorized by the grazing system are presented in Table 4.11. The gross revenue included the value of milk sold and that consumed by the household. Results indicate that the total value of milk produced by each lactating cow per month was higher in the zero grazing enterprises. On average, the value of milk in the zero grazing system was Ksh. 6,091, compared to Ksh. 5,189 in other grazing systems. However, households practicing the zero grazing systems incurred higher monthly variable costs per lactating cow (Ksh. 5,156) compared to Ksh. 3, 622 for non-zero grazing system. These costs translated to variable cost of production per litre of milk of Ksh 12 and Ksh 9 for zero-grazers and non-zero grazers, respectively. As

expected, the cost of milk production was higher for the more intensive dairy production system. Consequently, the gross margin in the zero grazing system was lower, with a monthly return over variable costs of Ksh. 935. In the non-zero grazing system, the gross margin was Ksh. 1,567, which is 1.7 times higher than that in the zero-grazing system. Therefore, there is evidence of higher gross margins per cow and per litre of milk for the non-zero grazing systems. Although the revenue per cow was lower for the non-zero grazing dairy farms, the much lower costs compensated for this, resulting higher gross margins per cow and per litre of milk.

The ratio of gross margin to variable expenses was low for all households regardless of the grazing system. This indicates that every shilling invested in total variable costs returned just a few cents. In the case of concentrates (an item that accounts for a large proportion of total variable cost), the return to every shilling invested was considerably higher in the non-zero grazing system. The gross margin rate (gross margin divided by the total revenues) was low on average, but higher for the non-zero grazing system. This means that a higher proportion of revenues in this system were available for covering fixed costs of land, labour, capital, and for a farmer's profit. Therefore, there was a financial advantage to the non-zero grazing dairying system.

Table 4.11: Gross margin analysis (per lactating cow per month) for smallholder dairy enterprises

Revenue (Ksh)	***Zero grazers***	***Non-Zero grazers***	***Sample***
Milk sales	5112	4183	4569
Value of milk consumed at home	978	1006	995
Total revenue	**6091**	**5189**	**5563**
Variable Expenses(Ksh)			
Transporting milk	465	408	416
Fodder	540	474	503
Veterinary & insemination expenses	388	525	468
Labour	643	781	723
Maintenance and repair	1,006	223	568
Consumables	60	62	61
Electricity and water	87	131	104
Concentrates	1,606	830	1201
Salt lick	361	187	257
Total variable expenses	**5,156**	**3,622**	**4,301**
Gross margin/cow/month (Ksh)	**935**	**1,567**	**1,262**

Summaries			
Gross margin rate (%)	15	30	22
Gross margin/variable expenses (Ksh)	0.2	0.4	0.3
Gross margin/concentrates cost (Ksh)	0.6	1.9	1.0
Average milk produced per cow per month (litres)	436	393	411
Variable cost of production per litre of milk (Ksh)	12	9	10
Gross margin per litre of milk (Ksh)	2	4	3
Average milk selling price (Ksh)	21	21	21
Concentrate cost/litre of milk (Ksh)	3.7	2.1	2.9

Gross margin analysis for dairy enterprises under both zero- and non-zero grazing systems, and categorized by milk sheds is as shown in Table 4.12. For the zero-grazing system, the value of milk produced per lactating cow per month was highest in Githunguri, followed by Trans-Nzoia and Kinangop and lowest in Nyeri. Similarly, monthly productivity per lactating cow was highest in Githunguri and lowest in Nyeri. The higher value of milk and productivity in Githunguri can be attributed to membership in the successful Githunguri Dairy Farmers Cooperative Society and Processor. The dairy farmers are vertically integrated into the Cooperative society. Milk collection, processing and marketing is the core activity for Githunguri Society but it also provides other services such as input supply stores (mainly feed) and A.I. services for its members. Services to members are not only reasonably priced, but are also offered on a credit basis. The members also obtain additional benefits from the Cooperative society such as the ability to obtain foodstuffs like maize flour on credit from the society's stores.

The findings further indicate that across the milk sheds, purchase of concentrates forms the largest share of the variable expenses except in Trans Nzoia. The cost of repairs and maintenance is highest in Trans Nzoia and substantial in other areas, but very low in Githunguri. The total variable costs were lowest in Githunguri, which translated to the highest gross margin per month per lactating cow (Ksh.5, 406), which was up to 12 times higher than in other areas. Although the variable costs in Trans Nzoia were higher than those in Kinangop and Nyeri, the former had a much higher gross margin. This may be attributed to higher milk productivity and price.

The gross margin in Nyeri was negative, indicating that the revenues received from milk were not sufficient to cover all the variable costs incurred. This could be as a result of the low milk

productivity in Nyeri compared to the other areas. Overall, in the short run, dairy production under the zero-grazing system was economically viable, except in Nyeri. The returns in the enterprise covered all the variable costs and had a positive return to capital, management and risk. The long-run viability of the enterprise is, however, dependent on its ability to cover all production costs.

Table 4.12: Gross margin analysis for the dairy enterprises under zero and non-zero grazing systems

	Zero-grazing system				Non-zero grazing system			
Item	**Githunguri**	**Kinangop**	**Trans-Nzoia**	**Nyeri**	**Kinangop**	**Trans-Nzoia**	**Nyeri**	**Kericho**
Revenue (Kshs)								
Milk sales	8,226	4,738	5,155	3,622	3,911	3,576	4,411	4,726
Value of milk consumed at home	1,151	801	1,303	929	830	873	1,095	1,162
Total Revenue	**9,377**	**5,539**	**6,458**	**4,551**	**4,741**	**4,449**	**5,505**	**5,888**
Variable Expenses (Kshs)								
Transporting milk	0	465	0	0	103	547	0	381
Fodder	455	566	528	573	498	735	271	119
Veterinary & insemination expenses	324	369	268	463	312	709	493	472
Labour	604	280	806	755	296	631	1,525	893
Maintenance and repair	143	1,048	2,860	1,115	1,275	84	125	108
Consumables	57	61	28	67	61	63	76	56
Electricity and water	51	111	50	105	144	120	0	122
Concentrates	1,931	1,663	671	1,600	1,076	1,019	1,063	568
Salt lick	406	544	269	250	167	164	159	224
Total variable expenses	**3,971**	**5,107**	**5,479**	**4,927**	**3,933**	**4,072**	**3,711**	**2,942**
Gross margin/cow/month (Ksh)	**5,406**	**432**	**979**	**-376**	**808**	**377**	**1,794**	**2,946**
Summaries								
Gross margin/variable expenses (Ksh)	1.4	0.1	0.2	-0.1	0.2	0.1	0.5	1.0
Gross margin/concentrates cost (Ksh)	2.8	0.3	1.5	-0.2	0.8	0.4	1.7	5.2
Average milk/cow/month (Litres)	565	436	476	358	381	317	492	429
*Variable cost/ litre of milk (*Ksh)	7	12	12	14	10	13	8	7
Average milk selling price (Ksh)	26	19	23	20	18	22	17	22

The variable cost of producing a litre of milk was lowest in Githunguri, a factor that can be attributed to better efficiency in production in the area. Farmers affiliated to Githunguri Dairy Cooperative benefit from extension advice offered through the Cooperative. The average price of a litre of milk was highest in Githunguri. Githunguri's vicinity to Nairobi gives the area an advantage as most of the milk from the area, both raw and processed, has an expansive market in the city. In addition, competition for milk from various buyers who flock the area positively affects price.

For the non-zero grazing system, revenue from milk produced by each lactating cow per month was highest in Kericho (Ksh.5, 888) and lowest in Trans Nzoia (Ksh.4, 449). The revenue was lower than that under the zero-grazing system except for the Nyeri milk shed. The gross margin per month per lactating cow was highest in Kericho (Ksh.2, 946) and lowest in Trans Nzoia (Ksh.377). Overall, in the short run, dairy production under the non-zero grazing system was economically viable in all milk sheds. Within the same milk shed, gross margin in Trans Nzoia was higher in the zero-grazing system, while in Kinangop and Nyeri, it was higher in the non-zero system. While the gross margin in Nyeri under the zero-grazing system was negative, that under the non-zero system was positive, and substantial enough to have a return of nearly Ksh 2 in gross margin for every shilling spent on concentrates. This result for Nyeri is mainly due to higher milk productivity under the non-zero grazing system.

The average milk produced by each lactating cow per month was highest in Nyeri (492 litres) and lowest in Trans-Nzoia (317 litres). The variable cost of producing a litre of milk was highest in Trans Nzoia and lowest in Nyeri. The average price of a litre of milk was highest in Trans-Nzoia and Kericho, with a litre selling at Ksh.22.

4.2.5 Participation in Milk Markets

This section focuses on participation of households in the milk market with regards to the proportion of households that sold milk; amount of milk sold; proportion of milk produced that was sold; and, milk prices offered by different buyers. The percentage of households that sold milk and the amount sold are presented in Table 4.13. Overall, a higher percentage of male than female headed households sold milk. A similar result was found using the household panel data.

In addition, male headed households sold more milk than their female headed counterparts except in the Nyeri milk shed.

Participation in milk markets can also be examined in terms of commercialization, defined as the percentage of value of marketed output to the total farm production (Haddad and Bouis, 1990). The value of milk sales as a percentage of the total value of milk production by milk shed and gender of household head is shown in Table 4.14. Across all milk sheds, more than 75% of the milk produced was sold, indicating that dairy production is mainly done as a commercial enterprise. There was no difference in the proportion of milk sold between male and female headed households. Across the milk sheds, this proportion was highest in Githunguri.

Table 4.13: Percentage of households that sold milk and amount sold

	% of households that sold milk		Amount of milk sold per month (litres)		
Milk shed	Male	Female	Male	Female	Total
Githunguri	90.0	10.0	1,185	900	1,155
Kinangop	95.5	4.5	676	255	657
Trans Nzoia	87.5	12.5	897	364	828
Nyeri	76.9	23.1	501	609	527
Kericho	91.7	8.3	588	529	583
Overall	**87.7**	**12.3**	**715**	**535**	**693**

Table 4.14: Percentage of value of sales of milk to value of milk produced

Milk shed	Male	Female	Sample
Githunguri	87	91	88
Kinangop	83	79	83
Trans Nzoia	77	76	77
Nyeri	76	82	78
Kericho	79	67	78
Overall	80	79	80

The sale price of milk is determined by various factors including season and area of production, channel of sale, and quality of milk. The price offered per litre of milk by different buyers between January and June, 2010 is presented in Table 4.15. Institutions such as schools, hospitals and hotels offered the highest price, whereas dairy cooperatives offered the lowest prices. Cooperatives offered the lowest price mainly because of the longer marketing chain associated with them. Producers selling through the dairy cooperatives delivered milk to

collection points, and then the milk was sold to other buyers such as institutions, processors, small and large milk traders at a profit.

Though the results indicate that dairy marketing cooperatives offered the lowest price, they have had a large contribution to rural development in Kenya. These cooperatives transport milk for members and also perform other services such as provision of inputs on credit. The cooperatives also enjoy significant economies of scale which are expected to minimize their cost of operations. They, however, face competition from other cash based marketing channels such as small scale milk vendors, large traders, institutions and individual consumers as farmers prefer their mode of payment.

Producers in Githunguri received the highest price, which can be attributed to the choice of the marketing channel, a large market due to its vicinity to the city of Nairobi, and also because most of the dairy processors are within the proximity of this milk shed, hence creating enormous price competition.

Table 4.15: Price per litre of milk offered by different buyers

Mean price per litre	Milk shed					
	Githunguri	Kinangop	Trans Nzoia	Nyeri	Kericho	Sample
Institutions	26.6		40.0	24.5	25.2	26.7
Large traders	25.2	18.0	25.5		19.0	23.6
Individual consumer/neighbor		19.9	23.9	22.9	21.8	22.3
Processors	26.4	20.9	19.2	20.0	21.4	22.1
Small scale milk vendors		18.9	21.3		21.0	20.1
Dairy cooperative		18.1	22.1	18.4	19.2	19.0
Sample	**26.0**	**19.0**	**22.4**	**19.0**	**21.7**	**21.0**

5. Summary of Key Findings and Conclusion

Kenya's dairy industry plays an important economic and nutrition role in the lives of many people ranging from farmers to milk hawkers, processors, and consumers. Using both panel and cross sectional data, this study set out to examine milk productivity trends and the performance of the dairy industry by determining variable costs of production and gross margin at the smallholder farm level for different grazing systems.

Results based on the panel data showed that the percentage of households keeping improved animals increased over the years, and was higher among male-headed households compared to female-headed households. As found in other studies, this may indicate that female-headed households have less access to improved dairy breeds and perhaps dairy technologies in general. There were also regional differences in number of cows kept. A higher proportion of households in the higher potential agricultural areas compared to those in the lower potential areas kept improved cows and had larger herd sizes. Additionally, the high-income households kept more cows than the low income households, particularly the improved breeds.

Milk productivity per cow per year increased between 2000 and 2007, with a decline in 2010 due the prolonged drought in most of 2008/2009 and 2009/2010 cropping years. In addition, productivity showed variation across the different agro-regional zones. It was higher in the higher potential areas, which is consistent with the finding that a higher proportion of households in the higher potential agricultural areas compared to those in the lower potential areas kept improved cows and had larger herd sizes. However, productivity in any year is associated with high monthly/seasonal variations. Productivity increased up the income quintiles, suggesting that dairy farming could be a preserve of the relatively better off households. The relatively low proportion of milk sold indicates that while dairy production was practiced by many households, most of them produced milk mainly for home consumption.

Purchase of concentrates formed the largest cost component among households practicing zero and non-zero grazing systems. The cost of maintenance and repairs was the next largest expense in the zero grazing system, while it was labour in the non-zero grazing system.

The performance of the smallholder dairy enterprises varied across the grazing systems. Both total value of milk produced by each lactating cow per month and monthly variable costs per lactating cow were higher in the zero grazing enterprises. As a result, the gross margin per cow per month in the zero grazing system was lower, with a monthly return over variable costs of Ksh. 935. In the non-zero grazing system, the gross margin was Ksh. 1,567, which was 1.7 times higher than that in the zero-grazing system.

Overall, the ratio of gross margin to variable expenses was low for all households regardless of the grazing system, with every shilling invested in total variable costs returning just a few cents. However, the return to a shilling invested in concentrates was considerably higher in the non-zero grazing system.

The gross margin rate was low on average, but higher for the non-zero grazing system. Therefore, there was a financial advantage to the non-zero grazing dairying system, since a higher proportion of revenues in this system were available for covering fixed costs of land, labour, capital, and for a farmer's profit.

Across the milk sheds, Githunguri had a higher productivity and value of milk compared to other areas under the zero-grazing system. This may be attributed to membership in the successful Githunguri Dairy Farmers Cooperative Society and Processor, where dairy farmers are vertically integrated into the Cooperative society, and receive a number of benefits through the cooperative. It also had the highest gross margin per month per lactating cow, which was up to 12 times higher than in other areas. In the short run, dairy production under the zero-grazing system was economically viable, except in Nyeri, which had a negative gross margin.

For the non-zero grazing system, revenue from milk produced and gross margin per month per each lactating cow per month were highest in Kericho and lowest in Trans Nzoia. Overall, dairy production under the non-zero grazing system was economically viable in all milk sheds in the short run. Within the same milk shed, gross margin in Trans Nzoia was higher in the zero-grazing system, while in Kinangop and Nyeri, it was higher in the non-zero system.

Unlike in the case of panel data, more than 75% of the milk produced was sold across all selected milk sheds, indicating that dairy production is mainly done as a commercial enterprise, with the proportion being highest in Githunguri (88%). This is because the cross-sectional survey targeted smallholder dairy in the major milk producing areas.

The overall better performance achieved in Githunguri compared to the other milk sheds indicates the importance of cooperatives in contributing to farmer incomes and rural development in Kenya.

In conclusion, smallholder dairy farming was an economically viable enterprise in Kenya, in the short run. However, dairy farm performance measures showed that pasture-based enterprises were somewhat more profitable than zero-grazing enterprises, when compared on a per cow or a per litre of milk basis.

6. Recommendations for Policy

Although there was a financial advantage to the non-zero grazing dairying system, the example of the Githunguri milk shed clearly indicates that dairying under the zero-grazing system can be equally profitable, an important finding in the face of the shrinking size of smallholder farms. Dairying in this area was associated with higher productivity, better milk prices and higher gross margins per cow per month. The better performance for dairying in Githunguri is attributed to the importance of cooperatives in enabling farmers to process and market their milk collectively. This model of vertical coordination in dairy production confers a lot of benefits to farmers, enabling them to produce profitably and hence collective marketing needs to be encouraged.

High costs for concentrates was reported in both zero and non-zero grazing systems. This indicates that farmers have to improve feed efficiency in order to increase their gross margin rate of return. This improvement could be achieved through investments in genetic improvements of cows kept and/or improving feed management, and other dairy management practices. These may require farmer training and better access to relevant information on dairy production through the extension system or the milk cooperatives. Therefore, greater commercialization of

the dairy sub-sector and an increase in smallholder incomes will come from improved technologies that will make the existing resources more productive.

Other specific policy themes could have a major positive impact on smallholder dairying cost structure and profitability in future, particularly in the presence of seasonal intra-year variations in production. These include creation of a strategic milk reserve to absorb excess milk during high production periods and stabilize milk production shortfalls in the dry season; investment in processing of long life dairy products to absorb excess production and expand to non-traditional markets; investment in infrastructure (roads, collection points, cooling plants and electricity) to ease milk collection and processing; and, speedy implementation of the national livestock feed policy to guide and promote on farm feed preservation.

References

Baltenweck , I. and Staal S.J (2000). Determinants of Adoption of Dairy Cattle Technology in the Kenyan Highlands: A Spatial and Dynamic Approach.

Brookside Dairy Limited Website: http://www.brookside.co.ke/bc_about.html

Business Daily posted Friday, February 19, 2010.

Olok-Asobasi , Frank and Sserunjogi, Mohammed (2001). Survey of Dairy Markets in Kenya and Rwanda and Opportunities for Ugandan Exports

Githunguri Dairy Farmers Cooperative website: http://www.fresha.co.ke/about-us/githunguri-dairy-farmers-cooperative/

Govereh, J., Jayne, T.S and Nyoro, J. (1999). Smallholder Commercialization, Interlinked Markets and Food Crop Productivity: Cross - Country Evidence in Eastern and Southern Africa. Department of Agricultural Economics and the Department of Economics, Michigan State University (MSU).

Government of Kenya (2008). Sessional Paper of the National Livestock Policy.

Government of Kenya (2006). Sessional Paper on Dairy Industry Development.

Haddad, L.J and Bouis, H.E. (1990). Agricultural Commercialization, Nutrition and the Rural Poor. A Study of Philippine Farm Households. Washington DC: International Food Policy Research Institute (IFPRI). Paper presented at the IAAE Conference, Berlin.

ILRI (2007). Markets that work: Making a living from livestock. Annual Report.

Karanja (2003). The Dairy Industry in Kenya: The Post-Liberalization Agenda. Paper presented at a Dairy Industry Stakeholders Workshop held in Nairobi, Kenya (27th August 2002).

Kaitibie S, Omore A, Rich K, Salasya B, Hooton N, Mwero D and Kristjanson P. 2008. Influence pathways and economic impacts of policy change in the Kenyan dairy sector. Research Report 15. ILRI (International Livestock Research Institute), Nairobi, Kenya. 58 pp.

Land O' Lakes (2008). Milk Shed Assessment and Small Business Organizations Needs Analysis.

Leksmono, C., Young, J., Hooton, N., Muriuki, H., & Romney, D. (2006) Informal Traders Lock Horns with the Formal Milk Industry: The role of research in pro-poor policy shift in Kenya, ODI/ILRI Working Paper 266.

Muriuki, H., A. Omore, N. Hooton, M. Waithaka, R. Ouma, S.J. Staal and P. Odhiambo 2004 The policy environment in the Kenya dairy sub-sector: A review.

Scholtz, M.M and S.M. Grobler. (2009) A systems Approach to the South African Dairy Industry. South African Journal of Animal Science vol.39 no.5

Smallholder Dairy Project (SDP). 2005. The uncertainty of cattle numbers in Kenya. SDP Policy Brief No. 10.Smallholder Dairy (R&D) Project. www .smallholderdairy.org

Standard newspaper, published on 23/03/2010.

TechnoServe (2008). The Dairy Value Chain in Kenya. Project report for the East Africa Dairy Development Program.

Theron, H.E. & Mostert, B.E., 2008. Comparison of Production and Breeding Potential of South African Dairy Herds on Different Feeding Systems. Nat. Milk Rec. Improv. Scheme Newsletter 13, 26-29.

Thorpe,W., H. G. Muriuki, A. Omore, M. O. Owango and S. Staal (2000). Development of smallholder dairying in Eastern Africa with particular reference to Kenya. A Paper prepared for the UZ/RVAU/DIAS/DANIDA-ENRECA Project Review Workshop, Harare, Zimbabwe.