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Characterization of dairy cattle farming in Mbeere District of Eastern Kenya

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Abstract

A comparison of farming systems in two divisions, Siakago and Evurore of Mbeere district of Eastern Kenya was made using data collected with a farm model, Integrated Modeling Platform for mixed Agriculture Crop sysTem (IMPACT). The model was validated with data collected in smallholder mixed crop and dairy farms in the semi-arid district of Kenya. Cross sectional data were collected in 17 farms in each division during the months of March and April, 2007. The data captured included: climate, land management, livestock management, labor allocation, farm's sales and expenses, and soil nutrient flow.

The mean household size was 5.3 and 5.1 persons for Evurore and Siakago, respectively. The common dairy cattle breeds were Aryshire and Friesian. The mean milk yield was 8.1 and 7.0 kg/d for Siakago and Evurore, respectively with a range of 2.5–10.2 kg/d. For the stall managed dairy animals, most farmers used crop residues and cut pastures as the main source of feed. The feeds were sourced from both within and outside the farms, and ranged from planted and natural forages, crop residues to commercial and home-made concentrates. In both divisions, the basal feed resource was maize stover. However, methods of processing the stover prior to feeding varied, either fed whole in unprocessed form to chopping using either machete (panga) or chaff-cutter. Rhodes grass was the main ley pasture, while natural pastures mainly consisted of *Cynodon spp* and *Rhychelyntrum* species. During the dry period, when various feed resources were in short supply, banana stems and cereal by-products (wheat and rice bran and pollard) were used to sustain the animals.

A snapshot analysis of farm cash flow identified three main sources of income; crops, dairy and off-farm. Crop and/or dairy farming constituted the major source of income. Annual income from crops was estimated at Kenya Shillings (KES) 1.8± 0.21 and 1.7± 0.29 million for Siakago and Evurore respectively whereas annual income from dairy farming was estimated at KES 3.3 ± 0.31 and 1.5± 0.08 million for Siakago and Evurore respectively. Off farm income was insignificant in some farms but was a major source of income for farmers in Evurore division.

The potential of both crop and livestock farming in contributing to the economy of households in the two Divisions was not realized and there is need to device strategies which would help farmers to reap maximum returns from agriculture, particularly under the current continuum of agricultural product value chain.

Key words: arid and semi-arid land, farm cash flow, IMPACT, income, smallholder dairy

Introduction

This study provides a comparison of farming systems under two different set ups in the semi-arid district of Mbeere of Eastern Kenya. In order to quantify the role of both crop and dairy farming in the district, a biological model cum decision support tool was validated using cross-sectional data collected from house holds in the marginal environment. World wide and more so in the tropics, agriculture plays a crucial role in the economy of both individual house holds and nations. Similarly, biological models have gained importance as farm decision support tools (Pezo, 2001; Quiroz et al 2005; Kavana and Msangi 2005).

There is growing recognition that economic activities in the rural areas are driven by agriculture and the various farming activities have both direct and indirect important consequences to the environment. However, for rural farming households such as those found in arid and semi-arid land (ASAL) areas of Mbeere in Eastern Kenya, there is an urgent need to increase farmer's incomes as a means of reducing poverty. With modeling, data from different farming systems can be accessed, synthesized and explicit analysis of changes in farm operations and their economic and environmental effect can be determined. This type of analysis allows both the farmers and policy markers to make informed decisions about the development of the agricultural sector.

This study used IMPACT model to collect primary data from two different farming systems in a semi-arid region in order to estimate variables like milk production, economic gross margins and sources of farm incomes, factors that are useful in farm characterization. Economic returns were measured in terms of gross margins. Gross margins are short run profitability indicators measuring the differences between the value of production and variable costs without taking into account fixed costs or the depreciation of capital items (Mataya and Tsonga 2001).

Objective

The objective of the study was to characterize dairy cattle farming in Mbeere District of Eastern Kenya using data collected with a farm model, IMPACT.

Materials and methods

Rural agriculture

In tropical Africa, livestock production is mostly practiced under smallholder farming systems (Herrero et al 2005; Waithaka et al 2006). Many of these smallholder farming systems in developing countries are also based on the interactions of crop and livestock enterprises. There are wide variations in inputs used and generally in the way the practices are carried out. However, with the use of decision support tools, although their usage remains very low (Bernues et al 1995), characteristics of different systems can be elucidated.

Dairy production is a major activity in the livestock sector and an important source of livelihood for over 600,000 small-scale farmers (Karanja 2003). Apart from milk, dairy cattle also provide manure, other marketed products such as calves and culls as well as other intangible benefits such as insurance and status symbol (MoLFD 2006).

In order to fully understand the characteristics of a particular dairy system, relevant data that provide a clear description of the system is needed. The data set involved although extremely large, can be easily assembled and synthesized with a model. However, in most tropical rural farming set ups, there are low to nil usage of farm decision support tools. Low dissemination, adoption and underutilization of livestock models in dairy cattle farm enterprises are due to a number of reasons such as inadequate understanding of the biophysical processes involved and lack of reliable data for calibration and validation of the models (Gonzalez-Estrada et al 2000; Thornton and Herrero 2001). In addition, livestock simulation models are developed for specified circumstances, when applied outside what they were defined for or adapted to, variations in prediction could be large and become less informative (Thornton and Herrero 2001). Regardless of these problems, livestock simulation models provide some of the many technologies of improving livestock production in Africa (Thorne 1998).

IMPACT Model

The specific tools used to generate information on the relationships between type of farm enterprise and economic returns were a combination of the IMPACT model and cross-sectional study of mixed crop-livestock farms.

The IMPACT tool was developed at ILRI (2003) and provides a protocol for collecting all the essential data characterizing a farming system. This data collection protocol is organized such that the flow of resources through all the farming activities and their interactions are described.

Farm-level information is organized in eight groups: climate, family structure, land management, livestock management, labor allocation, family's dietary pattern, farm's sales and expenses, and soil nutrient flow. IMPACT processes these data to provide a baseline analysis of the system's performance. IMPACT also provides a baseline analysis or "snapshot" of four livelihood indicators: cash flows, labor budgets, food and food security and soil nutrient balances.

IMPACT was developed to provide a robust data collection tool. It has standard input files and data exchange protocols to run and link models for purpose of assessing the impact of alternative management or policy interventions on tropical smallholder farming systems (Herrero et al 2005). One of its limitations is that it requires a large amount of data about a farming system for its calibration most of which is hardly kept by most smallholder farmers (Karanja 2003). Additionally, input of the data collected into the model's windows (screens) is systematic, meaning that where information on a particular window is not available, the calibration of the model cannot proceed. This presents a problem to the user in that he/she must provide information which he/she may not eventually use in the final analysis.

The output of the IMPACT model is in the form of data tables containing information characterizing the farming system. IMPACT is also able to analyze information from a farm's

database and produce outputs of four categories of resources in the farm namely, economics, food security, nutrient flow and labor.

Farm operation models are essentially integrated models which normally consist of individual models that are combined together to give one model. For example, digestion and ingestion models can be combined with other processes to give an integrated model (Illius et al 2000).

Low productivity of dairy cattle in semi-arid Mbeere is related to pervasive inadequate feed quantity and quality throughout the year. Farmers lack knowledge and information on appropriate nutritional management interventions to change the situation. The potential productivity levels attainable with the current feeding practices have not been quantified. Experimental approaches to determine the potential are costly in terms of time, resources and finances. Simulation modelling offers an effective approach to quantify the potential productivity levels with the present feeding practices.

Mbeere District falls within the semi- arid Districts of Eastern Province of Kenya. Eighty five per cent of Kenya's total land mass falls within the low potential areas (Herlocker 1999). Like other ASALs, the District experiences low livestock productivity (Onduru et al 2002; Karanja 2003; MoLFD 2006). Regardless of the arid conditions, dairy cattle production is one of the economic activities in the District (Owiro 1979; Onduru et al 2002). But challenges are experienced by dairy cattle farmers in Mbeere in providing optimal feeding resources through out the year (Kangara et al 1996; MoPND 2001; Onduru et al 2002; Kamau 2004). It is therefore prudent to generate and analyze all the data that provide appropriate description of the farming system and in particular, the descriptors of productivity of dairy cattle under smallholder system in the arid conditions of Mbeere. The data generated will provide information on appropriate management practices such as nutritional, disease and environmental factors that affect dairy cattle and crop agriculture in a marginal tropical environment Mbeere District was chosen for this study because the smallholder dairy farmers, just like majority of smallholders dairy farmers in others semi-arid and arid Districts, experience problems in feeding (Abate et al 1987; Onduru et al 2002; Gachimbi et al 2003). The two Divisions, Siakago and Evurore, are the main smallholder dairy cattle production areas in the District, with Evurore being more arid than Siakago (MoPND 2001; Onduru et al 2002)**.**

Data collection

The study was based on primary data from cross-sectional surveys from Evurore and Siakago Divisions of Mbeere District. The studies were conducted between March and April, 2007. The criterion of selecting the farmers was; the possession of at least one lactating animal, the presence of improved dairy cows (exotic and/ or crossbreds), the farmer's attitude of being open and participatory, being literate, i.e. able to read and write, and the willingness to share information freely.

In the cross-sectional study, a purposive sample of 34 smallholder farms practicing mixed crop livestock farming (17 from each of the Divisions) were selected and interviewed using the IMPACT (Herrero et al 2007**)** data collection tool (standard structured questionnaire). The number of 17 households selected for interview per Division was dictated by both the availability

of resources and the complexity of the IMPACT questionnaire. Data on household characteristics were collected which included: land size and crop/pasture patterns; gender and labor allocation in the farm; species and breeds of livestock kept; livestock feed resources and feeding practices; farm inputs and outputs; household income and expenditure and animal performance parameters such as milk production and body weight gain. For lactating animals, breed type, parity and stage of lactation were also recorded. For each farm, the household head was interviewed. Where the household was not available, the person with sufficient knowledge on farm operations was interviewed.

Data analysis

The cross-sectional data captured with the IMPACT questionnaire were entered in the computer using the IMPACT software. Livestock and household related summary data were synthesized using the IMPACT software following similar approaches to those adopted by Castelan-Ortega et al 2003 and Waithaka et al 2006. Analysis of data for descriptive statistics was conducted using the Statistical Analysis System program (SAS 1999). A snapshot baseline analysis of individual farm cash flow for three major enterprises (crops, dairying and off-farm) was done. This provided data on annual income of farms for each of the enterprises.

IMPACT software data containing records on household and livestock management information (household size, dairy cattle breeds and their number, dairy cattle herd structure and their feeding groups, livestock feeds and their costs, cow's daily milk yields and quantities of milk sold, and farm sources of income) were exported to Microsoft Excel spreadsheet for synthesis of summaries and for data storage. Comparative statistics characterizing the 34 farms were computed using the data.

Results and Discussion

Household characteristics

Data from one farm in Evurore Division was not consistent and it was dropped from the study. The average household size in Evurore and Siakago Divisions was 5.3 and 5.1 (median 5 and range 2-8) persons respectively (Table 1). The variation is explained by the fact that Evurore is mainly a rangeland (ecological zones IV and V and with less than 1000mm of rainfall per year) and majority of the smallholder dairy cattle owning households are settled in riparian environments. The riparian area is small leading to a bigger number of residents, higher population density and hence smaller tracts of land in Evurore. Siakago is located mainly in ecological zones III and IV and thus wetter. The whole area is usable explaining the higher mean land ownership (6.2 ha) in Siakago as compared to the mean of 4.9 ha for Evurore.

Level of literacy in the study area was high with 97% of the respondents having primary level of education and above (Table 1). In Siakago, all respondents had attained formal education.

Each of the households combined dairy cattle rearing with other economic activities (mainly cropping) to enhance their income. Dairy cattle's rearing was considered as a form of income diversification by most of the households.

Table 1. Mean household size (person), level of education and general characteristics of household owners in Evurore and Siakago Divisions of Mbeere District (March–April 2007).

Parameter	Evurore	Range	Siakago
Mean household size (no)	5.3(±1.88)	2-8	5.1(±1.67)
Mean land size (ha)	4.9(±4.41)	0.1-11	6.2(±6.91)
Literacy			
University graduate (no)	1		0
Secondary level (no)	11		12
Primary level (no)	3		5
Non formal education (no)	1		0
Occupation			
Employed (no)	5		6
Business (no)	5		4
Involved in farming only (no)	4		5
Gender			
Males (no)	12		14
Females (no)	4		3

Source: *Cross-sectional study*

In the two Divisions, smallholder dairy enterprise was integrated into multipurpose farming systems, relying on food (maize, beans, cow peas, pigeon peas, cassava, pawpaw, bananas) and cash crops (Mangoes, tobacco, miraa-*Catha edulis*) supported by off-farm income from towns through the extended family network. This description is similar to that given by Onduru et al (2002) who observed that the District is largely a low agricultural potential zone meaning that crop production is a difficult venture.

Composition of dairy herds

Pure bred exotic dairy cattle and their crosses were found in both Divisions. The most common breeds were Aryshire which were kept by 21% and 18% of farmers in Siakago and Evurore, respectively (Table 2). Friesians were kept by 12% farmers in each of the two Divisions while only 6% of farmers kept pure Guernseys in Evurore Division. The most common dairy cattle cross was Friesian-Aryshire cross which was kept by 12% of farmers in both Divisions, in Siakago and in Evurore Division. The indigenous Zebu cattle breed was kept, by 3 % of farmer in each of the two Divisions, probably due to biased selection of the farms. There were more farmers keeping more than one breed of dairy cattle in Evurore than in Siakago.

Table 2. Breeds of dairy cattle kept by the households in Evurore and Siakago Divisions of Mbeere District (March–April 2007)

Breed	Evurore (n=16)	Siakago (n=17)
Friesian	4	4
Aryshire	6	7
Guernsey	2	0
Jersey	1	0

Friesian x Aryshire cross	4	4
Friesian x Jersey cross	0	1
Zebu-local	1	1
Total	18	17

The main breeds of dairy cattle observed in this study were Aryshire and Friesian and their crosses. This composition has been reported in other parts of the country (Kiragu et al 1998; Potter, 2001; Muhuyi et al 2001; Onduru et al 2002). However, Onduru et al 2002, working in the same District observed that the main breeds of dairy cattle were crosses of Friesian, Guernsey, Aryshire, and Jersey and for the period of 1991-2001, and those dairy cattle breeds accounted for only 1.3% of total cattle population in the District.

Herd structure

The herd structure of the animals in both Evurore and Siakago are shown in Tables 3 and 4 respectively. There were more adult Aryshire cows and more young Friesians, an indication of new preference for Friesians. In Siakago, farmers commonly kept Aryshire and crosses of Friesian-Aryshire. Few Friesians and Zebus were kept. Most of the lactating cows and young stock were Aryshire. Where male animals were kept, they were for draught to ferry water and feed for the milking herd. None of the respondents used bulls to serve the cows but some farmers kept bulls for fattening and sale as meat animals to diversify their income.

Table 3. Herd structure of dairy cattle in Evurore Division of Mbeere District (March–April 2007)

	Division		**EVURORE n= 16**		
Breed	**lactating**	**dry**	**heifer**	**calf**	**Total (no)**
Jersey	1	1	0	0	2
Friesian x Jersey cross	2	0	0	0	2
Friesian	8	3	5	6	22
Aryshire	16	0	0	8	24
Guernsey	4	0	1	0	5
Friesian x Aryshire cross	8	1	2	3	14
Zebu-local	3	0	0	2	5
Total	42	5	8	19	
Males*					
Young bull				7	7
Mature bull				4	4

**Note: Young bulls are males of up to 2 years of age while mature bulls represent all males over 2 years of age*

Table 4. Herd structure of dairy cattle in Siakago Division of Mbeere District (March–April 2007)

	Division		**SIAKAGO n= 17**		
Breed	**lactating**	**dry**	**heifer**	**calf**	**Total (no)**
Jersey	0	0	0	0	0
Friesian x Jersey cross	0	0	0	0	0
Friesian	6	4	3	1	14
Aryshire	27	3	8	12	50

Guernsey	0	0	0	0	0
Friesian x Aryshire cross	7	3	3	3	16
Zebu-local	1	3	0	0	4
Total	41	13	14	16	
Males*					
Young bull				7	7
Mature bull				22	22

**Note: Young bulls are males of up to 2 years of age while mature bulls represent all males over 2 years of age*

Mbeere District falls within the ASAL region of the country thus experiences high ambient temperatures and scarcity of feed, an environment favorable for the 'hardy' breeds of dairy cattle such as Aryshire (Muhuyi et al 2001; Bebe et al 2003). Compared to the large breeds, Friesian and Guernsey, the Aryshire are hardy, consume less feeds and can withstand low level of management explaining its popularity with farmers in the District. Farmers indicated that they bought restocking animals from their neighboring households and hence increasing the population of the most common breeds. Additionally, PLAN International had funded a bull camp project in the 1990s aimed at upgrading local cattle through Aryshire bulls given to farmer groups (Onduru et al 2002) which has also contributed to the popularity of Aryshire genotypes in the District.

The smaller dairy breed, Jersey, was not common with farmers as they were of the opinion that the breed was similar to the indigenous Zebu breed in size and productivity compared to the Friesian and Aryshire. In both Divisions, the dairy herd composition was similar with the proportion of both lactating and dry cows at 64% with lactating cows being the majority, 57% and 48% for Evurore and Siakago respectively. Similarly, calf and heifer proportion was 36% but Siakago had a higher proportion of heifers of 17% as compared to that of 10% of Evurore. The small percentage of young animals in the herd can affect the future stability of dairying because young animals, particularly heifers are raised to replace old cows. Various proportions are reported for smallholder dairy cattle (Wilson 1986; Muriuki 2002; Bebe et al 2003; Karanja 2003; Kedija 2007). In a study of smallholder dairy systems in Kenya highlands, Bebe et al (2003) reported Zero grazing herd structures of 40.86 % cows, 19.6 % bullying heifers, 9.35 % heifer calves, 10.82 % immature males, 10.44 % male calves and 8.92 % mature male. Therefore, the higher proportion of cows in herd structures found in the study area was attributed to the farmers management strategy of retaining fewer heifers , possibly only when need for a replacement was anticipated or when there were sufficient feed resources (Bebe et al 2003). Additionally, the high proportion of female animals was an indication that the rearing of dairy animals was newly introduced in the area and was yet to stabilize (Onduru et al 2002).

The higher percentage of female animals observed in herds in this study was in agreement with Muhuyi et al (2001) who found out that in Zero grazing herds surveyed in the semi-arid Rongai Division of Nakuru District, females accounted for over 60 per cent. The proportion of adult to young animals observed in this study (73%) differs with those reported by Potter (2001) and Muhuyi et al (2001) of 50 per cent. The smaller proportion of young stock observed in this study was possibly because of location, ASAL where there are challenges in feeding (Staal et al 1997a) which affect survivability of young stock (Kibiru 2007). Presence of few heifers is an indication

of fertility problem and future unavailability of cows. The infertility problem was supported by long calving intervals (13.8± 9.22, range 12 to 42 months) which resulted in reproductive wastage in the smallholder dairy herds. Reproductive wastage is associated with inadequate quantity and quality of feed, lack of bulls, inefficient delivery of artificial insemination (AI), poor access to veterinary services and difficulties in estrus detection (Omore et al 1996; Lanyasunya et al 1999).

Lactation performance of dairy cattle

Tables 5 and 6 show the average milk production of different breeds in the two Divisions. The Aryshire Friesian cross performed slightly better though non significant (P>0.05) than the other breeds in both Divisions (10 l/d in Evurore and 10.2 l/d Siakago). Friesians had the second highest yield in both Divisions, with a mean milk yield of 9.9 and 9.0 l/d for Siakago and Evurore Divisions respectively.

Table 5. Actual milk yield by breed per cow per day (l/cow/day) in Evurore Division of Mbeere District (March–April 2007)

Division	**Evurore**		
	Number of cows	**Mean (l/d/cow)**	**SD**
Jersey	1	3.5	-
Friesian x Jersey cross	2	9	±0.71
Friesian	8	9	±3.25
Aryshire	16	7.1	±1.56
Guernsey	4	5.8	±2.51
Friesian x Aryshire cross	8	10	±0.96
Zebu-local	3	2.1	±0.36

Source: *Data captured in cross-sectional study.*

Table 6. Actual milk yield by breed per cow per day (l/cow/day) in Siakago Division of Mbeere District (March–April 2007)

Division	**Siakago**		
	Number of cows	**Mean (l/d/cow)**	**SD**
Jersey	-	-	-
Friesian x Jersey cross	-	-	-
Friesian	6	9.9	±4.78
Aryshire	27	8.1	±3.51
Guernsey		-	-
Friesian x Aryshire cross	7	10.2	±4.61
Zebu-local	1	2.5	-

Source: *Data captured in cross-sectional study.*

The indigenous Zebu cows had the least mean yield of 2.5 and 2.1 l/d for Siakago and Evurore Divisions respectively. Although the Aryshire cows were kept by most farmers, their lactation performance was moderate as compared to the other breeds with a yield of 8.1 and 7 l/d for Siakago and Evurore Divisions respectively. Animals in Siakago Division performed relatively

better than in Evurore Division which could be attributed to Siakago having more feed resources from both pastures and crop by-products.

The average milk production of dairy cows in the Divisions was 8.8 ± 4.49 l/d for Siakago compared with 7.8 ± 2.89 l/d for Evurore. Similar levels of production have been reported (GoK 1989; Irungu and Mbugua, 1998; Muhuyi et al 2001; Muraguri et al 2004). Irungu and Mbugua (1998) reported a mean lactation yield of 3009 kg translating to 9.9 litres per day for cows purely grazing Rhodes grass leys in Nakuru District. Muhuyi et al (2001) reported a lactation yield of 2407.47 in 239 days for zero-grazing system in Rongai Division of Nakuru. Onduru et al (2002) reported milk production for dairy cattle in Mbeere District to be in the range of 3-4 litres per day for a lactation period of 200-250 days. Muraguri et al (2004) reported a mean annual milk yield of 1787 kg/cow/year and 2195 kg/cow/year for non supplemented and supplemented cows respectively in smallholder dairy in Kwale District (translated to 5.85 and 7.20 kg/day respectively). The mean annual yield of 8.3 ± 3.69 l/d observed in the current study is more than 7.5 l/d reported by Kiragu et al (1998) in Bahati and Naivasha Divisions of Nakuru District and 4 l/d reported by Onduru et al (2002) in Mbeere District. Low yields were attributed to poor nutrition (low availability of quality feeds) and low to no supplementation with commercial feeds. Omore et al (1996) Staal et al (1997a) and Onduru et al (2002) made similar observations.

Livestock feed resources

Maize stover was used as basal livestock feed by all the farmers (Table 7). Most, 90%, however, combined cut and carry forage from natural pasture grasses with the maize stover. The maize stover was mainly from within the farm with few farmers 45%, purchasing from other farms. A higher percentage, 88%, of the farmers used commercial concentrates (mainly Dairy Meal®, Wheat bran and Wheat pollard). Dairy Meal® is a commercially compounded feed composed mainly of maize bran, wheat bran, cotton seed cake, soybean meal and fish meal and nominally 16% crude protein (Kategile and Mubi 1992: Franzel et al 2003). Napier grass was used by 84 % of the respondents with fodder trees (*Leucaena spp,* and *Morus spp*) only available in 12% of the farms. Only 9 % of the households used ley pasture of Rhodes grass, mainly in the form of conserved loose hay. Banana stems (both pseudo stem and leaves) was an important feed resource for 39% of the farmers in both Divisions. During the dry period, banana stems were particularly important feed for dairy cattle. Natural pasture grasses were fed in 63% of farms.

Farmers in Siakago owned bigger parcels of land (mean of 6.2 ha), thus more farmers grew natural pasture grasses for livestock feeding. During the dry period, 87% farmers purchased grass hay (grass and rice straw) and the commercial concentrates to feed animals. Farmers unable to purchase forage or concentrates relied on banana pseudo stems, either from their own farms or purchased from neighbors and natural pasture grasses harvested from road reserves to maintain the animals.

Commercial concentrate (Dairy Meal®) was used to supplement lactating animals during milking, the quantity given ranged from 1-2 kg based on the financial ability of the farmer. However, to reduce costs on feeding, 18% of farmers used a mixture of Dairy Meal and wheat

pollard at the ratio of 50:50, hoping that the mixture would offer the same nutritional value as dairy meal but a clear indication of low level of knowledge on dairy cattle nutrition.

Table 7.Types of livestock feeds and Percentage of farmers using them in Siakago and Evurore Divisions of Mbeere District (March-April 2007).

Division	Maize stover (%)	Napier grass (%)	Banana stem (%)	Rhodes grass (%)	Natural grass* (%)	Fodder trees** (%)	Commercial concentrates*** (%)
Evurore(n=16)	100	93	43	0	56	12	87
Siakago(n=17)	100	76	35	17	70	11	88
Total (no)	33	28	13	3	21	4	29
Percentage	100	84.8	39.4	9.1	63.6	12.1	87.9

**Natural pasture was mainly Rhychelyntrum spp, **Fodder trees consisted of Leucaena spp, and Morus spp, ***Commercial concentrates consisted of Dairy Meal®, Wheat bran, Wheat pollard.*

The main animal feed resources observed in the study area were Napier grass, Dairy Meal® and natural pastures. This is consistent with findings by other authors (Staal et al 1997b; Irungu et al 1998; Kiragu et al 1998; Muhuyi et al 2001). Maize stover and banana pseudo stems have been reported as important feed resources in zero grazing systems by a number of authors (Staal et al 1997a; Kiragu et al 1998; Potter, 2001). Few farmers, 12%, were observed to utilize fodder trees for livestock feeding indicating that farmers did not have sufficient knowledge on the mode of utilization and value of browse as a feed supplement. A similar observation was made by others (Kiruiro et al 1998; Roothaert and Franzel 2001; Franzel et al 2002; Onduru et al 2002). Fodder trees are a knowledge-intensive practice requiring considerable training and facilitation, especially the first time farmers establish a nursery and again, about nine months later, at harvesting (Franzel et al 2003).

Livestock management

Dairy cattle in the two Divisions were reared either under zero-grazing or semi zero-grazing system. Seventy nine percent of farmers in Evurore and 88% in Siakago practiced zero-grazing, while 21% in Siakago and 12% in Evurore practiced semi-Zero grazing system. Dairy cows were preferably kept under zero grazing to enhance their feed management and overcome the challenge of tick-borne diseases (Kangara et al 1996). There were more farmers, 88%, in Siakago practicing zero grazing than in Evurore, 79%. This was explained by the fact that farmers in Siakago had bigger parcels of land, setting aside some for grazing than the counterparts in Evurore.

Land utilization

Growing of both food crops and fodder tress was a common practice in the two Divisions. The main food crops grown were maize, beans, cowpeas and bananas. Mango trees and Miraa (*Catha edulis*) were the main cash crops. Similar observations are reported (Onduru et al 2002; Gachimbi et al 2003; Kamau, 2004). Onduru et al (2002) reported that food crops such as maize, millet, sorghum, beans, cowpeas, green grams, cassava, and bananas were grown for subsistence whereas the main cash crops were cotton and tobacco. Kamau, (2004) observed that forage is not

always available during the dry season and hence farmers look for alternatives to supplement the little available forage.

The main fodder grass was Napier grass. Where farms were left fallow, grasses such as *Digitaria spp* and *Rhychelyntrum spp* were harvested for fodder. In both Divisions, more land was dedicated to crops (83% and 82% for Siakago and Evurore) than pasture (17% and 18% for Siakago and Evurore). Farmers in Siakago allocated more land for crops, since emphasis was on crop agriculture as opposed to dairy cattle. The land area under pastures was uniform in the two Divisions. The area allocated to crops and pastures observed in this study support the work of Gachimbi et al (2003) who observed that farmers in Gacavini village of Gachoka Division of Mbeere District allocated 89 % of the land to cropping but contrast with the work by Muhuyi et al (2001) who found that farmers practicing zero grazing in Rongai Division of Nakuru could allocate up to 58% of their land to forage production.

Source of income

Snapshot analysis of farm cash flow with IMPACT identified three main sources of income; crops, dairy and off-farm income (Table 8, and Figure 1). The individual farm incomes per each of the sources were summed up to provide an estimate of annual income on Divisional basis as shown in Table 8 and figure 1. Crop and/or dairy farming constituted the major source of income. Annual income from crops was estimated at KES 1.8± 0.21 million in Siakago compared to KES 1.7± 0.29 million earned by farmers in Evurore Division. Annual income from dairy farming in Siakago was estimated at KES 3.3 ± 0.31 million compared to KES 1.5± 0.08 million in Evurore Division. Off farm income was insignificant in some farms but was a major source of income for farmers in Evurore. These farmers had a combined net off farm income of KES 1.1 ± 0.12 million as compared to the combined net value of KES 0.35 ± 0.03 million earned by farmers in Siakago. Households in Siakago had a higher annual combined net farm income (KES 5.6± 0.22 million) compared to those in Evurore who earned KES 4.4 ± 0.18 millions. In Evurore, income from livestock accounted for 34% of the annual income opposed to 61% in Siakago. This observation contradicts the work of Gachimbi et al (2003) who reported that the main sources of income in the District in order of priority were agriculture, livestock and cash remittances. Farmers in Siakago had embraced dairying due to the favorable climate in the Division and the proximity to a ready market for milk in Siakago Township. Evurore Division falls under arid conditions where cropping is risky due to unreliable rainfall explaining why farmers had to rely more on off-farm income.

Table 8. The estimated annual income from crops, livestock and off-farm sources (Million KES) of farmers in Siakago and Evurore Divisions of Mbeere District (March- April 2007)

Divisions	Siakago	Evurore
Enterprise		
Crops	1.8 ± 0.21	1.7± 0.29
Livestock	3.3 ± 0.31	1.5 ± 0.08
Off-farm	0.35 ± 0.03	1.1 ± 0.12

Figure 1. Sources of Income (Million KES) of farmers in Siakago and Evurore Divisions of Mbeere District (March-April 2007)

Gross income accrued from milk production was higher in smallholder farms of Siakago than of Evurore. However, total cost of milk production was higher in Evurore than in Siakago leading to a smaller difference in gross margins as compared to the difference in gross income between the two divisions. This observation indicates that aiming for higher gross income could not necessarily result in realization of higher gross margins as well.

Conclusions

- The study indicated that majority of household in Mbeere practiced mixed farming with both crops and livestock contributing significantly to livelihood.
- The smallholder dairy farmers in Mbeere District relied on natural pastures and crop by-products for livestock feeding. However, they had little control on the availability of the feed resources.
- Smallholder dairy farmers got between 7.8 and 8.8 litres/cow/day from either exotic or crossbred dairy breeds. The full potential for milk production from dairy cattle breeds has not yet been realized in Mbeere District of Kenya.
- IMPACT tool was effectively used for both data collection and analysis for farm characterization in the mixed farming households of Mbeere District.

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