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Research Application Summary

Smallholder cattle dairy under semi-arid conditions: opportunities and challenges

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Abstract

Dairy has gained prominence among pastoralists and agro-pastoralists in the Kenyan rangelands albeit with many challenges. A study was conducted to characterize smallholder cattle dairy in semi-arid Mbeere District, Eastern Kenya. Farmer practices and animal productivity of stall managed lactating cows were analyzed. Exotic cattle were reared and fed roughage and concentrates at 16.5 - 20.2 kg and 2- 3.3 kg, respectively, in processed/ unprocessed form. Forages were mostly conserved in open or under roofed hay barns but some conserved the harvested grasses, cereal and legume crop by-products in baled bundles. Silaging was not used to preserve forages. During drought, banana stems and cereal by-products were used to sustain animals. Feedstuffs were of moderate feed values exposing farmers to challenges in feeding lactating cows. The study recommends improvements in farmer's capacity on alternative forage conservation and utilization methods, silaging and baling, among others, in order to increase milk yields.

Key words: Feed value, Kenya, roughage, silaging, smallholder-dairy

Résumé

Les produits laitiers sont très importants pour éleveurs et agro- éleveurs des parcours au Kenya, malgré les nombreux défis. Une étude a été menée pour caractériser les petites exploitations laitières dans le district semi-aride de Mbeere, dans l'est du Kenya. Les pratiques agricoles et la productivité animale des vaches en lactation ont été analysées. Les bovins exotiques ont été élevés et nourris aux fourrages brutes et concentrés respectivement à raison de 16,5 à 20,2 kg et de 2 à 3,3 kg sous forme transformée / non transformée. Les fourrages étaient surtout conservés dans des étables à foin ouvertes ou sous toiture, mais certains conservaient les sous-produits des graminées récoltées, des céréales et des légumineuses dans des balles. Pendant la sécheresse, les tiges de bananiers et les sous-produits céréaliers sont donnés aux animaux. L'ensilage n'était utilisé pour conserver les fourrages. Les aliments présentaient une valeur nutritive modérée, exposant les agriculteurs à des difficultés d'alimentation des vaches en lactation. L'étude recommande d'améliorer la capacité des agriculteurs à utiliser d'autres méthodes de conservation et d'utilisation des fourrages, notamment pour l'ensilage et la mise en balles afin d'augmenter les rendements laitiers.

Mots clés: Valeur alimentaire, Kenya, fourrage, ensilage, petits exploitants

Introduction

Small holder dairy has gained importance as an economic activity among residents of semi arid Mbeere district (Onduru *et al.,* 2002; Karanja, 2003; Katiku *et al.,* 2011). There is growing recognition that economic activities such as dairying are having important consequences on people's livelihoods and on the environment. However, for rural farming households in the Arid and Semi-Arid Lands (ASAL) areas of Mbeere in Eastern Kenya, there is an urgent need to increase farmers' incomes as a means of reducing poverty and improving livelihoods. There is also growing demand for milk for feeding an increasing population. Similarly, there is need to increase the efficiency of farm operations by reduction costs of farm operations such as those resulting from feeding of stall managed dairy animals. The analysis of feedstuffs, their mode of utilization and their feed value allow both the farmers and policy makers to make informed decisions about the development of the agricultural sector (ILRI, 2001). The objective of the study reported herein was to determine varieties, mode of preservation, utilization and feed value of locally available feedstuffs in smallholder dairy farms in Mbeere District, Eastern Kenya in order to quantify the potential feeding value and the sustainability of locally available feedstuffs in feeding lactating dairy cattle in a tropical semi arid dairy farming system.

MATERIALS AND METHODS

Smallholder dairy cattle. The specific tools used to generate information was a combination of longitudinal studies and single subject interviews of key stall managed dairy cattle keepers in the district. The tools were used to obtain information on the types of feedstuffs, their mode of utilization and the feed value of locally available feed materials used in feeding stall managed dairy cattle in two divisions, Evurore and Siakago, in the semi-arid area of Mbeere district and the lactation performance of stall managed dairy cattle

Data collection. Initially, single subject interviews of a random sample of 33 smallholder dairy cattle farmers from the two divisions, Siakago and Evurore, were conducted. Primary data were collected for a period of three months in a longitudinal study involving 12 farms with 27 heads of stall managed dairy cows in various stages of lactation, six from each of the two Divisions. The 12 farms were purposively selected from the 33 farms. The selection of participating households was based on the possession of at least one lactating dairy cow, ability to keep records and willingness to participate in the study. Data collected included types of feeds and amounts fed, feeding regime/practices, milk yields and cow parameters such as age, parity, calving interval and stage of lactation.

An individual animal data card was used to record data on breed and parity, lactation length and milk yields, feed types and daily intake and calving interval. To allow for accurate recording of milk yield at the farm, farmers were provided with 1 litre graduated cups (Fig. 1). Similarly, farmers were provided with a 50 kg spring balance (Fig. 2) for weighing of feeds given to the animals. Subsequent data on type and weight of feed (s) consumed, milk yield, and cases of sicknesses were recorded for a period of three months mainly by the individual farmers. However, for purposes of accuracy in data recording, monitoring visits were made to the farms on ad hoc basis whereby records were checked and unclear details

were explained by the farmer.

Each of the participating farmers was trained on feed sampling and was provided with feed sample bags for preserving samples of the feeds given to the animals. Succulent feed samples were initially weighed and air dried under the sun for three days to minimize spoilage.

Photo 1. Graduated measuring cup **Photo 2.** Weighing feedstuff using a suspended 50 kg spring balance

Laboratory analysis. The feed samples were dried at 60^0C for 48 hours and ground with a Willey mill 0.5mm screen. The samples were analyzed for dry matter (DM) and crude protein (CP) content with the micro kjeldahl technique (AOAC, 1990; ILRI, 2001) and invitro dry matter digestibility (IVDMD) using the two stage technique for digestion of forage crops (Tilley and Terry, 1963). The Van Soest procedure was used for analysis of the fibrous forages.

D**ata analysis**. The longitudinal survey data collected from 12 respondents from each of the two divisions, Evurore and Siakago, consisted of both quantitative and qualitative variables. For the qualitative variables, a codebook was created using the Microsoft Excel version 2007 (2007). For quantitative variables, descriptive statistics (means, standard deviation, minimum, and maximum values) were compiled. Percentages and frequencies were analyzed in Microsoft Excel.

RESULTS AND DISCUSSION

Potential feed categories for feeding dairy cattle. Dairy cattle farming in Mbeere District was practiced by ordinary farmers, retired officers, civil servants and business women/ men whose main purpose was to diversify income to increase their incomes (Onduru *et al.,* 2002; Katiku *et al.,* 2011). Majority of farmers (87%) planted pasture for their dairy animals while the rest relied mainly on natural pasture grasses and legumes (Table 1). However, crop by-products and commercial concentrate feeds were widely used in all farms.

The potential feed resources in the study area and their nutritive values are shown in Table 1. The feeds were grouped into four categories: crop by-products, fodder grasses, trees and shrubs, concentrates and natural pastures. The crop by-product feed category, with the widest varieties, formed the feed base for majority of the farmers. This agrees with findings of Nyaata *et al.* (2000) and Njarui *et al.* (2011). Even though such materials are readily available in most farms and commonly utilized to feed dairy cows, they are associated with high fibre content that render them inappropriate and insufficient for feeding high grade dairy cows. In terms of their nutritive value, they are low in CP, 2-5%, and low ME values of 5-7 MJ ME/kg (Smith 2002). The materials were conserved in structures; roofed barns with open side walls were used by over 81% of the households (Table 2). However, the materials were not sufficiently available throughout the year. The planted fodder feed category - *Pennisetum purperium*, *Leucaena leucocephala*, *Morus alba*, *Chloris gayana*, *Glycine* spp, *Calliandra* spp., *Sorghum* spp and *Manihot* spp, had the second wider varieties and also relatively cheaper material for feeding. However, they were considerably underutilized, possibly because of low level of knowledge among the farmers, an observation reported by Lukuyu *et al.*(2011).

Table 1. Dry matter, crude protein, fibre and *in-vitro* dry matter digestibility of feedstuffs in the study area

Feed name	DM g/kg	CP g/kgDM	IVDMD (g/kg)	NDF (g/kg)	ADF (g/kg)	ADL (g/kg)
1. Crop by-products						
Maize (-*Zea mai*s) -dry stover	841	39	563	78.44	40.59	4.19
Banana pseudo stems and leaves (Musa spp)	135	45	650	74.69	33.08	7.92
Young banana sucker (*Musa* spp)	131	50	650	56.03	41.35	5.94
Cassava tubers (*Manihot* spp)	102	29	675	50.03	9.14	3.05
Sweet potato vines- vines and leaves	233	103	750	60.05	36.22	8.84
Paw paw dry leaves-(*Papaya* spp)	849	41	557	50.05	46.22	9.84
Mixture of Napier and maize stover (ratio 50:50)	516	71	563	77.79	43.58	6.41
Market waste -mixture of kales and cabbage leaves and ripe banana peeling	394	117	787	50.88	31.65	7.79
Mixture of dry maize stover, napier grass and dry bean haulm (ratio 3:2:1)	616	123	585	71.57	46.71	8.29
Sorghum straw-*Sorghum* spp	836	65	532	73.84	46.35	5.99
Butter nuts	160	93	492	26.44	19.24	7.37
2. Fodder						
Calliandra leaf fodder (fresh)	484	212	582	40.10	24.72	10.83
Dwarf Leucaena leaf fodder- dried (*Leucaena* spp)	887	220	452	68.78	51.26	9.91
Giant Leucaena leaf hay (*Leucaena* spp)	712	248	500	58.78	46.26	7.91
Mulberry fodder-fresh (*Morus* spp)	592	181	590	39.56	25.01	7.30
Napier grass- fresh material (*Pennisetum* spp)	325	63	616	67.88	38.58	5.09
Rhodes grass- hay *Chloris* spp –	849	88	556	81.44	47.69	7.72
3.Concentrates						
Dairy meal-Commercial concentrate	894	120	749	41.99	12.44	4.39
Wheat bran	891	134	582	69.67	34.32	9.04
Home concentrate-milled whole	811	94	758	64.37	28.71	1.37

maize only						
Rice bran	919	85	664	72.67	44.32	8.04
Wheat pollard	863	157	735	37.46	13.96	4.12
4. Natural pasture						
Natural pasture hay (*Rhychelyntrum* spp)	271	95	571	58.65	25.97	9.52
Bush legume – leaves and stems (*Glycine* spp) (fresh)	216	119	568	38.65	26.97	8.52
Grass weeds hay-*Cynodon* spp	869	52	587	68.65	38.97	7.52

Majority of the farmers relied on crop residues for feeding their grade dairy cows for almost year round, but dominantly in the dry months of February and July to October. The materials were of moderate nutritional value as shown in Table 1. The fibre content of most of the rough materials was high. There was little evidence of use of modern technology to improve on the quality except on the use of simple chopping techniques. Therefore, there is need to introduce and advocate for modern crop residue utilization and quality improvement strategies to improve on the performance of the dairy cattle of the main stakeholders, farmers. Additionally, farmers need to be made aware of the importance of mineral salts in the entire process of nutrition. The feeding of common salt (sodium and chloride) is economical way of supplementing diets particularly during the dry season when feed is scarce (NAS, 1976).

Methods of feed processing, conservation and utilization. Farmers in Mbeere formulated rations (Fig. 1) for feeding their lactating stall managed dairy cows using materials from the four feed categories shown in Table 1. Farmers employed simple techniques in processing roughages fed to dairy animals. The technique involved chopping roughages prior to feeding. However, the techniques varied from use of simple implements such as machetes and ordinary chaff cutters to use of motorized chaff cutters (Figures 3a and 3b). Chopping reduced the feed particle size (Fig. 3c). Majority of the farmers (76%) practiced one form of feed processing. This was beneficial to both the farmers and the animals. Processing increased the efficiency of feed utilization by reducing choice and preference and increasing rumen digestion. It is reported (Methu, 1998) that chopping and chaffing enhance intake of roughage materials by ruminants by lowering the intake constraints. However, farmers were not using other feed additives such as molasses to improve both the feed value and intake of the fibrous forages.

Table 2. Methods of feed preservation, utilization and types of conservation structures practiced by smallholder dairy cattle households in Evurore and Siakago Divisions of Mbeere District (March–July 2007)

Parameter	Evurore (n=16)	Siakago (n=17)
Roofed barns	12	15
Conserved in bales	3	7
On farm feed processing	12	13
Feeding unprocessed feed	2	6
Planted Fodder -grass	15	13
Planted fodder- legumes	4	6
Mechanized feed processing	5	7
Silage making	0	0

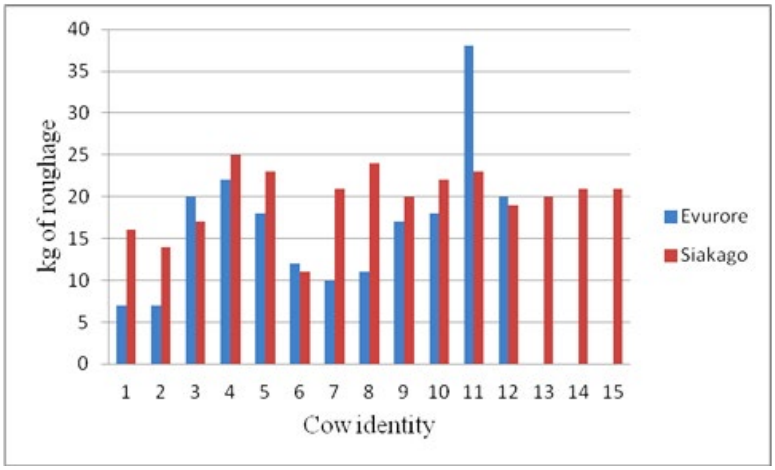

Figure 1. Quantities of roughages feed to dairy cows on daily basis in smallholder dairy farms in Evurore and Siakago Divisions of Mbeere District (March, 2007)

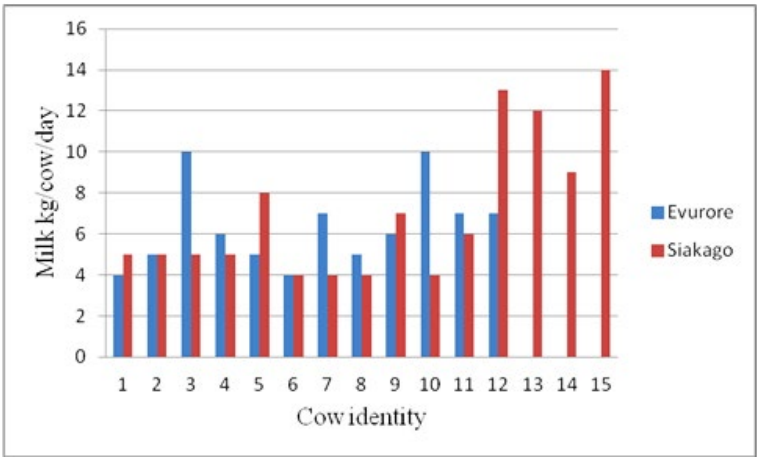

Figure 2. Daily milk yield of smallholder dairy cows in Evurore and Siakago Divisions of Mbeere District (March, 2007)

Photo 3a: Ordinary chaff cutter **Photo 3b:** Motorized chaff cutter

Photo 3c: Chopped napier grass forage

Photo 4: Roofed structure used to preserve roughage feed (dry maize stover)

It was observed that each of the farms made rations based on the feed resources available in the farm, which varied between farms. In order to mitigate against the vagrancy of dry weather conditions, when feeds were in short supply, farmers conserved roughages as shown in Figure 4. However, there were variations in the forms of structures used, ranging from open roofed barns to open unroofed structures (Njarui *et al.,* 2011). Feed conservation extends the quantity and availability of forage for livestock feeding particularly during the dry season which in most cases prolong for over 5 months in the ASALs. The issue of inappropriate storage methods (lose hay, standing hay in the field, open barns, hanging in tree tops) results in decline in nutritive value. Similarly, farmers conserve small quantities and occasionally harvest materials at the wrong time such as before blooming or beyond 50% flowering stage perhaps because of lack of knowledge (Njarui *et al.,* 2011).

The kind of feeding regime observed in Figure 1 and Table 3 indicates that low amounts of forages (<20 kg/cow/day) were provided to lactating dairy cows during the study period that resulted in underfeeding, a common feature in most smallholder farms (Agenas *et al.,* 2003). Forage was normally available in abundant quantities in the study area during long and short rainy seasons (Onduru *et al.,* 2002; Kamau, 2004) which are March to June and October to December, respectively. The rest of the months were dry, a period when farmers relied on either conserved feeds or commercially procured feed resources. The commercial feed stuffs were not easily accessible to most of the resource poor smallholder farmers (Karanja, 2003; Katiku *et al.,* 2011). Farmers resorted to using poor quality roughages, mainly from category four and one of the feed resources in category three but the least costly to maintain the animals. A small percentage (30%) of the farmers conserved roughages in bales. However, all the farmers interviewed indicated that the conserved roughages were hardly sufficient for feeding their animals throughout the year. Baling is a simple technology that farmers employ to harvest and preserve forages for use during the periods of scarcity. However it was not widely applied in the study area possibly because of low level of knowledge. Even though silage making was another alternative option that farmers could employ for preserving the succulent green fodder during the periods of plenty, mainly the wet seasons, the technology was not practiced by the households interviewed in the current study Silaging and box baling are low cost feed conservation systems for smallholder farms (Massawe *et al.,* 1998; Methu and Mbuthia, 2005), however farmers require exposure and some initial and basic training of the technologies.

Poor nutritional status of animals, exhibited by provision of either poor quality or small quantities of forages, was reflected in the productivity performance (Fig. 5) of the mostly grade cows, with moderate yields (7 kg/cow/day) being recorded during the period as was also reported by Lukuyu *et al.,* 2011. There is need to develop a sustainable feeding management that incorporates supplementation strategies for enhancing milk yield even during the dry months for both household food security and as well as for income generation (Waithaka *et al.,* 2002).

It was observed that only 30% of the monitored farms used browse from fodder trees. Fodder trees are a knowledge-intensive practice requiring considerable training and facilitation, especially the first time farmers are establishing a nursery and at about nine months later, at harvesting (Franzel *et al.,* 2003).

Table 3 shows the actual amounts of feed fed to the individual cows in the farms. It was observed that farmers did not have a concise method of determining the quantities of feed offered to cows. However, cows were fed on the type and amount of feed that was available irrespective of body weight and milk yield (Waithaka *et al.,* 2002; Ongadi *et al.,* 2007).

The concentrates mainly consisted of commercial feeds. However, in two of the farms, it was observed that whole maize was milled without any additives and designated as concentrate. Again, farmers fed the concentrates at a fixed rate of 2kg/cow/day as opposed to the standard practice of feeding concentrates based on the level of milk yield meaning that farmers lacked the appropriate knowledge on feeding lactating cows. The total amount of each feed category consumed by a cow was the sum total of the different quantities offered in a day as estimated with a spring balance.

The amount of roughages and concentrates offered varied both between and within farms with a mean daily consumption of 18.6 ± 6.77 (range 7- 38) kg and 2.74 ±1.77 (range 2-8) kg, respectively. The variations in feeding resulted in a corresponding variation in milk yield (Table 3) by cows both between and within farms. The variations observed in yields for cows on the same farm offered the same feed was possibly explained by the difference in breed, age, stage of lactation and quantities of feed offered. The variation in yield also showed a seasonal trend, with higher yields realized during the wet season, a trend also reported by Njarui *et al.* (2011).

Conclusions

The smallholder dairy cattle keepers in the two Divisions, Evurore and Siakago, relied mainly on locally available roughages for feeding grade cows. Even though mechanical processing was employed to reduce the feed particle sizes, the procedure did not yield better results of the much anticipated outcome of improving the lactation performance. Farmers could got 6-7 kg/cow/day of milk from exotic dairy cattle breeds through provision of medium quality forage in amounts of less than 20 kg/cow/day. In order to realize the full potential of milk production from exotic dairy cattle breeds, even during dry months, February and July – October, farmer's capacity on alternative forage conservation

methods, silage making and forage baling, need enhancement. Therefore, there is need to introduce and advocate for modern crop residue utilization and quality improvement strategies, to improve on the performance of the dairy cattle. Additionally, farmers need to be made aware of the importance of mineral salts in the nutrition of the animals.

Table 3. Formulated diets and corresponding milk yield of dairy cows in Siakago and Evurore Divisions of Mbeere District.

Cow No	Farm	Roughage (kgDM/d) as fed	Concentrate (kgDM/d) as fed
1	11	7	2
2	11	7	2
3	11	20	2
4	9	22	2
5	9	18	2
6	8	12	2
7	8	9	2
8	8	11	2
9	10	15	2
10	10	18	2
11	7	38	2
12	7	21	2
13	1	15	2
14	1	15	2
15	1	15	2
16	1	25	2
17	6	25	4
18	3	11	2
19	3	22	2
20	3	25	2
21	12	19	2
22	5	24	2
23	5	24	2
24	2	18	8
25	2	21	5
26	2	22	5
27	2	22	8
	Mean	18.55	2.74
	SD	6.77	1.75

SD = Standard deviation

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