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Traditional cow and camel milk production and marketing in agro-pastoral and mixed crop–livestock systems: The case of Mieso District, Oromia Regional State, Ethiopia

Improving Productivity and Market Success of Ethiopian Farmers

Traditional cow and camel milk production and marketing in agro-pastoral and mixed crop–livestock systems: The case of Mieso District, Oromia Regional State, Ethiopia

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Abstract

The study was conducted in Mieso district of Oromia Regional State, located 300 km east of Addis Ababa and at about 200 km east of Adama. The objectives of the study were to characterize the traditional milk production and marketing system, as well as identify constraints and opportunities for further development. Five rural *kebeles*, Dire Kalu, Gena, Huse Mendera, Hunde Misoma and Welda Jejeba, that have milk production potential were selected using purposive sampling. Farmers/agro-pastoralists from each rural *kebele* were selected using Proportional Probability to Size (PPS) approach and a total of 120 farmers/agro-pastoralists were selected using systematic random sampling method. Group discussion was conducted with key informants such as elders and experts in the Office of Pastoral and Rural Development to have an overview of the overall milk production and marketing system. The information generated in participatory rural appraisal phases was used for the preparation and development of a questionnaire for the formal survey. The questionnaire was pre-tested and modified as necessary. The formal survey was conducted by trained enumerators in 2005/06 using 120 farmers. To capture gender effects in the overall production system, the sample household on each rural *kebele* was stratified into female- and male-headed households. For the market study, from the three existing market sites, Mieso and Asebot markets were purposively selected. Milk marketing was monitored during the rainy and the dry seasons. A questionnaire was used to collect information on the amount of milk delivered, price and number of individuals who sell milk. During the monitoring phase, a diagnostic survey was undertaken to identify households that have lactating cows and/or camels in the selected five rural *kebeles*. Lactating cows were stratified into early (1–2 months), mid (3–4 months), and late (5–6 months) lactation stages while camels were stratified into early (1–3 months), mid (4–6 months) and late (7–9 months) lactation stage, depending on their lactation length in order to see the production potential at different stages. About 10% of the total lactating cows and camels in each lactation stage from each rural *kebele* were used. Daily cow milk yield (morning and evening) was measured using a calibrated plastic jog for a period of one week. For camels, daily milk yield was measured three times a day (morning, mid-day and evening).

Cattle, camels and goats are used for milk production in the district. All milk animals in the study area are indigenous breeds. All the respondents indicated that cattle, camel and goats are principally fed on natural pasture on non-arable lands maintained under rainfed conditions. Crop residues, mainly sorghum and maize thinnings (locally known as *chinki),* sorghum and maize stover (locally known as *kera*), and household waste all serve as important feed resources for livestock. As an additional feed, mineral soil salt (locally known as *haya)* is used by about 40% of the respondents during the wet and

the dry seasons. Average cow milk yield/head per day in the wet and the dry season was estimated at 3.26 ± 0.07 litres and 1.63 ± 0.04 litres, respectively. Similarly, camel milk yield/head per day in the wet and dry season was 7.12 ± 0.33 litres and 3.85 ± 0.203 litres, respectively. The estimated average cow milk produced per household per day during the wet and the dry season was 4.80 ± 0.22 litres and 2.37 ± 0.11 litres, respectively. Similarly, the estimated average camel milk produced per household per day was higher during the wet (13.19 ± 0.95 litres) than the dry season (7.63 ± 0.82 litres).

Milk and milk product sale (96%) and crop sale (95%) are the major sources of income for the farmers/agro-pastoralists, indicating that both commodities are equally important. The majority of the households sell whole milk (78%) and butter (67%). Only 4.2% of the respondents sell whey. About 72% of the respondents indicated that cow milk is sold both during the wet and dry seasons. Some 8.3% of the respondents sell milk only during the wet season. Twenty-nine per cent of the households indicated that only one-fourth of the total household milk production is delivered to the market, and mostly the morning milk is sold while the evening milk is often used for home consumption. During the dry season, the amount of cow and camel milk supplied to the market decreases by 39 and 28%, respectively. The amount of cow and camel milk sold per day was significantly ($P \leq 0.05$) higher in Mieso (496.6 ± 19.12 litres) than in Asebot market (187.89 ± 19.12 litres). Milk sold per day during the wet season was significantly ($P \leq 0.05$) higher than during the dry season for both cow and camel milk. There were generally two types of milk outlets identified in the district. These are traditional milk associations or groups and individual sellers. The traditional milk producer association group is locally called *Faraqa Annanni*. From a total of 94 households that sold milk during the study, only 22 households (23%) were involved in the milk seller groups. The average amount of milk contributed by an individual in group marketing was significantly ($P \leq 0.05$) higher (3.94 ± 0.17 litres/person) than individual sales (1.64 ± 0.06 litres/person). The total amount of milk sold (litre/person per day) at the two market sites differed significantly, being higher in Mieso (3.27 ± 0.17 litres/person) than in Asebot (1.91 ± 0.06 litres/person) market.

Distance of the household from the market was an important variable which significantly ($P \leq 0.05$) affected decision on cow milk marketing. Availability of *Faraqa Annanni* in the area also had a significantly ($P \leq 0.1$) positive relationship with participation in cow milk marketing. Availability of *Faraqa Annanni* in the vicinity increased the opportunity of the household to market cow milk by 14%. Most of the respondents indicated that milk sale was highly affected by low milk quantity (73%) followed by distance to market (38%). Cultural taboo on milk marketing was limited and was identified by only 7.6% of the respondents, indicating that this issue is not a serious problem in the area. Feed scarcity, water shortage, security problem and limited access to veterinary services were identified

as the major problems to dairy production by 41, 30, 14.5 and 8% of the respondents, respectively. Mortality due to diseases was identified as a major cause of loss in cattle (65% of respondents) and camels (67% of respondents).

In conclusion, this study has shown that there is a good potential for market-oriented dairy development in the *woreda*. However, there is need for intervention to develop infrastructure, enhance input supply system, and undertake capacity development and training to enhance the skills of farmers and pastoralists in dairy production, processing and marketing. Attention should also be given to effective conflict management and resolution including the application of customary systems, improved access to veterinary services including training of paravets, improved feed production and conservation systems, feeding strategies and systems, improved milk handling, processing and marketing system and introduction of improved dairy breeds in some areas where feasible.

1 Background

Ethiopia, a landlocked country in the Horn of Africa, is located at 8.0º N and 38.0º E (The World Fact Book 2002). The total land area of the country is 1.1 million km^2 and the total human population is estimated at 79,221,000 (CSA 2008). More than 80% of the Ethiopian population is dependent on agriculture of which livestock production plays a significant role (Bureau of African Affairs 2006). Agriculture contributes to 47% of the country's GDP and to more than 80% of the export, and employs over 85% of the population (Bureau of African Affairs 2006). The contribution of livestock and livestock products to the agricultural economy accounts for 40%, excluding the values of draught power, transport and manure (Winrock International 1992). Livestock serve as a source of income and food security and also indicate prestige and social status in the rural community.

Although Ethiopia holds the largest livestock population in Africa estimated (excluding some Regional States) at about 43.1 million heads of cattle, 23.6 million sheep, 18.6 million goats, 0.62 million camels, 34.2 million chicken, 1.7 million horses, 4.5 million asses, 0.33 million mules and 4.9 million beehives (CSA 2008), the total national milk production remains among the lowest in the world, even by African standard. The total annual milk production in Ethiopia from about 10 million milking cows is estimated at about 3.2 billion litres, and this translates to an average production of 1.54 litres/cow per day (CSA 2008). The contribution of the different livestock species to the total production is about 81.2% from cattle, 6.3% from camels, 7.9% from goats and 4.6% from ewes (CSA 2008). Due to the highly perishable nature of milk and mishandling, the amount produced is subjected to high post-harvest losses. Losses of up to 20–35% have been reported in Ethiopia for milk and dairy products from milking to consumption (Getachew 2003). Total annual milk production increased at a rate of 1.2% for indigenous stock and 3.5% for improved stock (Tsehay 2002). Per capita milk consumption in the country is about 16 kg/year, which is much lower than African and world per capita averages of 27 kg/year and 100 kg/year, respectively (Saxena et al. 1997). Hence, about 6 million tonnes of additional milk are required per annum to feed the population as per the world standard (Saxena et al. 1997). This indicates the existence of a wide gap between the potential demand of the growing population of Ethiopia and supply of milk and milk products. In order to meet the growing demand in Ethiopia, milk production has to grow at least at a rate of 4% per annum (Azage 2003). Given the considerable potential for smallholder income and employment generation from high-value dairy products (Staal and Shapiro 1996), the development of the dairy sector in Ethiopia can contribute significantly to household income, poverty alleviation and nutrition in the country.

Overall milk production system in Ethiopia could be broadly classified as pastoral and agro-pastoral, mixed crop–livestock and peri-urban and urban dairy production systems. The highland comprises 40% of the country's land area, holds 88% of the human population and 74% of the tropical livestock units (TLU). The main activity is a mixed crop–livestock farming system dominated by crop production and accounts for more than 90% of the country's economic activity (CSA 2008). In contrast, the lowland has 78 million hectares land area (60% of total) and 12.2% of the total human population. Ecologically it has arid (64%), semi-arid (21%) and subhumid (15%) areas dominated by pastoralist population whose economy is entirely dependent on livestock production (Solomon 1999). Pastoral areas extend from the northeast Afar lowlands to the western lowlands of Benishangul Gumuz including the southeast (Somali Region), southern (Borana) and southwest (Southern Omo). Cattle, camel and goats are the main livestock species that supply milk. Cow milk production is the major activity as source of food and income. Cattle dominate the livestock population (55.4% of the TLU) followed by camels (15.3%), goats (13.7%) and sheep (6.4%) (Coppock 1993). Milk from small ruminants and camels is also important in the diets of the pastoralists. In the lowlands, about 65.7% of the goats and 67.9% of the sheep are female flocks and are used for milk production and reproduction. The lowland in general accounts for 27% of the total milk production in Ethiopia (Getachew 2003). Because of the erratic rainfall pattern and related reasons resulting in shortage of feed, milk production per unit is low and highly seasonal. More milk is produced in the wet season where pastoralists would mostly conserve and convert the surplus milk into butter and trade with the highlanders for grain in peripheral markets.

The livestock subsector in Ethiopia is less productive in general, and compared to its potential, the direct contribution to the national economy is limited. The poor genetic potential for productive traits, in combination with the substandard feeding, health care and management practices that animals are exposed to are the main contributors to the low productivity (Zegeye 2003). Low rainfall, high temperature and low forage production, common plant association, livestock and human carrying capacity, incidence of important livestock diseases and parasites, mainly define the lowlands. In the past, most of the interventions to develop the dairy sector focused more on increasing production, specially in the so-called high potential areas and with less attention to input supply and marketing systems and government engagements focused on input supply-oriented services aimed at tackling problems restricting increases in milk production, with little attention to the development of appropriate milk marketing and processing systems. In general, the development of improved marketing system is pivotal to increase production (Tsehay 2002).

It is therefore apparent that there is a need to study dairy production and marketing systems in the lowlands using a systems approach for research and development as the most appropriate tool for gaining knowledge of the factors that influence the production system (Ibrahim 1998). Moreover, these approaches are also important to furnish essential information and experiences for future dairy development efforts in the lowland areas. Therefore, this study was undertaken with the following objectives: (1) to characterize the milk production and marketing system, (2) to identify major constraints for the development of market-oriented dairy production, (3) to formulate recommendations for further interventions, and (4) to provide baseline information for scaling up similar development activities in other similar agro-ecologies and production systems.

2 Materials and methods

2.1 Description of the study area

The study was conducted in Mieso district of Oromia Regional State, located 300 km east of Addis Ababa and at about 200 km east of Adama town (Figure 1). It is located west of Somali region and is one of the *woredas* in Oromia where pastoralist farming system is practised. The *woreda* has a total number of 37 rural *kebeles* and four town dwellers' associations. The total human population of the *woreda* is estimated at 145,775, and is composed of 22,012 agricultural rural households and 6785 urban households. The total rural population is 115,568, out of which 58,612 (51%) are male. Of the total rural households, 17,495 (80%) are male-headed households.

The *woreda* has a total area of 2573.44 km^2 (about 196,026 ha) and is situated between 40º9″30′ E and 40º56″44′ E; and 8º48″12′ N and 9º19″52′ N. The district's altitude ranges between 900–1600 masl. The mean annual temperature varies between 24ºC–28ºC. The mean annual rainfall ranges from 400 to 900 mm, with an average of about 790 mm (IPMS 2006). Agro-ecologically, the *woreda* is classified as lowland (*Kolla*). The area receives a bimodal rainfall where the small rains are between March and April while the main rains are between July and September. During the small rains, farmers plant long seasoned sorghum, which lasts for about eight months (April to November). However, during the main rains, maize, teff and sesame are planted. Haricot bean is also planted intercropped with maize in almost all places. Rainfall during the main rains is unpredictable and erratic, and as a result, crops fail in most years due to lack of even distribution of rainfall. Recurrent drought is a major problem, and is making relief aid a regular source of livelihood for many rural families. A total land area of 22,487 ha (about 12% of the *woreda*) is considered suitable for crop production (Table 1), indicating that the *woreda* is much of a rangeland where livestock rearing is a major activity.

Table 1. *Land use and land cover type of Mieso* woreda

Land use	Area coverage (ha)
Arable land	22,487*
Grazing land	17,362
Forest and bush	56,296
Potentially cultivable	46,415
Uncultivable land (hills)	48,466
Homesteads	5000
Total	196,026

*Of these, 21,010, 1097 and 380 ha were under annual, perennial and vegetable crops, respectively.
Source: Mieso *Woreda* Pastoralist and Rural Development Office (2003/04).

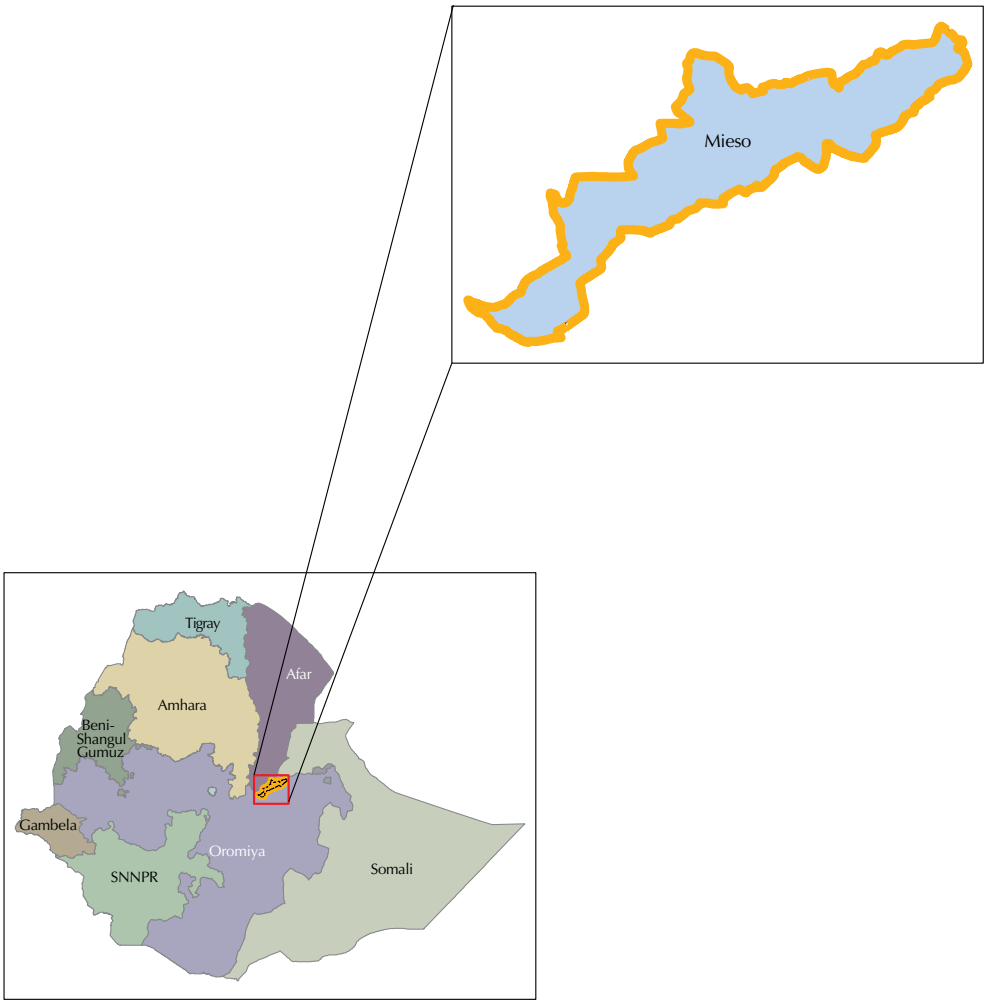

Figure 1. *Elevation map of Mieso district, Oromia Region, Ethiopia.*

Three livestock production systems exist in Mieso district (Figures 2 and 3); pastoralists make up about 80%, agro-pastoralists 15%, while the remaining 5% are engaged in crop/livestock production and petty trade in urban centres (Save the Children 2004). About 38% (73,658 ha) of the total land area is covered by bushes, forests and grazing land, and is the major feed resources for livestock in the district. The natural vegetation is dominated by *Acacia* species with some under growth of grasses. From the total land area, 11.5% is arable land, 9% is grazing land, 29% forest and bushes, 24% is potentially cultivable, 25% uncultivable land (hills) and 2% is homestead (IPMS 2006).

Figure 2. *Pastoral (left) and agro-pastoral (right) production system in Mieso district.*

Figure 3. *Crop–livestock production system in Mieso district.*

2.2 Sampling and data collection

2.2.1 Sampling procedure

Preliminary survey was conducted in the rural *kebeles* in order to obtain the total number of households that have dairy animals (cattle and/or camels). Five peasant associations that have potential for dairy production, i.e. Dire Kalu, Gena, Huse Mendera, Hunde Misoma and Welda Jejeba were selected using purposive sampling procedure. The number of farmers from each rural *kebele* was determined using Proportional Probability to Size (PPS) approach. To capture gender effects, the

sample households in each rural *kebele* were stratified into female and male-headed households, and this served to determine the number of households. From each rural *kebele,* individual households were selected using systematic random sampling method and a total of 120 farmers were selected based on the number of households in each *kebele*.

2.2.2 Survey

During the PRA phases, group discussion was made with key informants such as elders and experts in the Office of Pastoralists and Rural Development to have an overview about the milk production and marketing system. The information generated during the PRA phases was used for the preparation and development of a questionnaire for a formal survey. The questionnaire was pre-tested and modified as necessary. Finally, the formal survey was conducted by trained enumerators under close supervision and participation of the researchers. During the formal survey, all the required data were collected for the period 2005/06 using 120 respondents.

2.2.3 Rapid appraisal

Before the start of milk yield monitoring under field conditions, diagnostic field work was undertaken to identify households that have lactating cows and/or camels in the selected five rural *kebeles*. Based on these data, lactating cows were stratified into early (1–2 months), mid (3–4 months), and late (5–6 months) stages of lactation, while camels were stratified into early (1–3 months), mid (4–6 months) and late (7–9 months) stages of lactation. For the monitoring study, about 10% of the total lactating cows and camels in each stage of lactation from each rural *kebele* were used. Daily cow milk yield (morning and evening) was measured using calibrated plastic jog for a period of one week. For camels, daily milk yield was measured three times a day (morning, mid-day and evening).

For the market study, from the three existing markets, two (Mieso and Asebot markets) were purposively selected due to their relative importance and ease of accessibility. Milk marketing was monitored both in the rainy and dry seasons by assigning enumerators at each marketing gates/routes. At the market sites, farmers and agro-pastoralists were briefed about the objective of the study before monitoring in order to ensure their cooperation. Elders who are familiar with the community were used as facilitators. The study covered 28 days, one week from each market per season. To asses the milk marketing system, information on location of farmers, amount of milk delivered to the market, prices and number of individuals who sell milk was collected using a questionnaire.

2.2.4 Data analysis

Most of the data were analysed with SPPS version 12.1 software (SPSS 2003). This involved simple descriptive statistics such as mean, range and percentile for crop and grazing land holdings, livestock holdings, amount of milk produced, consumed and marketed. ANOVA (analysis of variance) was used to test the variability of different variables among rural *kebeles* and household heads such as crop and pastureland holdings, livestock holdings, age at first calving, calving interval, amount of cow and camel milk produced and marketed. Chi-square test was used to examine differences between levels of significance of different variables among rural *kebeles* or between household heads for parameters such as type of income and expenditure, importance of dairy animals, constraints in dairy production, feed and water shortage. Simple and multiple correlations were used to estimate degree of relationship among the parameters such as crop and grazing land holding, and number of animal holding. GLM (General Linear Model) procedure with t-test and Duncan's multiple range test were used to test differences in age at first calving, calving interval at different rural *kebeles*, variability of price for cows and camel milk at different seasons and the amount of milk disposed to the market in wet and dry seasons.

3 Results and discussion

3.1 Land holding and use

3.1.1 Cropland holdings

Results from the survey indicated that the majority (47%) of household heads had cropland, which was in the range of 1–1.5 ha (Table 2). Only about 13% of the households owned cropland in the range of 3 to 4 ha. This indicates that land is a scarce commodity and this might be due to increasing population pressure in the district. In addition, the rural *kebeles* included in this study are relatively more peaceful than other rural *kebeles* in the district and this has resulted in the migration of more people to these rural *kebeles* due to tribal conflict. This has created serious shortage of cropland as well as grazing land.

Table 2. *Cropland size (per household) distribution in the Mieso district*

Cropland (ha)	Frequency	Per cent
1–1.5	56	46.7
2–2.5	49	40.8
3–4	15	12.5

Mean (± SE) cropland holding was 1.76 ± 0.06 ha (Table 3). There was a significant ($P \leq 0.05$) difference among the five rural *kebeles* in cropland holding. Dire Kalu rural *kebele* had more farm size (2.46 ± 0.13 ha) than the rest of the rural *kebeles*, while farmers at Gena rural *kebele* had the smallest area of cropland (1.48 ± 0.73 ha).

Table 3. *Variation in cropland holding size (ha) among rural* kebeles *in Mieso district*

Rural *kebeles*	No.	Mean ± SE	P value
Dire Kalu	15	2.46 ± 0.13a	
Gena	21	1.48 ± 0.16b	
Huse Mendera	34	1.97 ± 0.12b	0.00
Hunde Misoma	27	1.50 ± 0.10b	
Welda Jejeba	23	1.57 ± 0.07b	
Overall	120	1.76 ± 0.06	

SE = Standard error of mean, Sig. = Significant value, No. = Total number of respondents. Means followed by different superscripts differ significantly at $P < 0.01$ level.

Positive correlation ($P < 0.05$) was detected between the number of oxen holding and family size with cropland holdings. The equation on the relationship between number of oxen and family size with cropland holdings is as follows:

$$\text{Cropland size (ha)} = 1.136 + 0.26\ (\text{number of oxen}) + 0.159\ (\text{family size})$$

3.1.2 Pastureland holdings

Out of the total respondents only 33% of the households had pastureland, and of these 75.5 and 24.3% had temporary and permanent grazing land, respectively. Temporary land is used by either making enclosure during the rainy season on the cropland or on the communal lands. Permanent grazing land is a marginal land or land not used for cultivation and is used for grazing animals communally.

As indicated in Table 4, the size of pastureland owned per household ranged from 0.25 to 0.75 ha for the majority (74%) of the households. This implies that grazing land in the study area is scarce. This may be due to population pressure leading to conversion of more pastureland to cropland and due to the conflicts between different tribes, which does not allow the proper use of the existing pastureland.

Table 4. *The overall distribution of ownership of pastureland in Mieso district*

Pastureland (ha)	Frequency	Per cent
0.25–0.75	29	74
1–2	6	15
>5	4	10

The average pastureland size of the sampled households was 1.32 ha, with a range of 0.25–10 ha. There was a significant ($P \leq 0.05$) variation among different rural *kebeles* in pastureland holdings (Table 5). Dire Kalu had significantly large size (6.8 ± 1.71 ha) of pastureland per household than other sampled rural *kebeles*. Households in the Dire Kalu rural *kebele* allocate their land largely (6.8 ± 1.71 ha) for grazing rather than for cultivation (2.46 ± 0.13 ha). This is because their livelihood is dependent more on animal rearing than crop cultivation.

Table 5. *Variations in pastureland (ha) holding by rural* kebeles *in Mieso district*

Rural *kebeles*	Total no. of respondents	No.	Mean ± SE	P value
Dire Kalu	15	5	6.80 ± 1.71a	0.000
Gena	21	6	0.50 ± 0.09b	
Huse Mendera	34	8	0.31 ± 0.04b	
Hunde Misoma	27	3	0.83 ± 0.58b	
Welda Jejeba	23	17	0.62 ± 0.06b	
Overall	120	39	1.32 ± 0.39	

No. = Sample respondents, SE = Standard error of mean. Means followed by different superscripts differ significantly at $P < 0.01$ level.

3.2 Livestock species and herd composition

Cattle, goats and camels are important dairy animals in the district (Figure 4). As indicated in Table 6, the average livestock holdings per household in Mieso district was 5.69 ± 0.35 cattle, 6.03 ± 0.30 goats and 1.83 ± 0.92 camels. There were more goats (44%) than cattle (42%) and camels (14%) in the study area. In Somali Regional State, however, the proportion of livestock species owned by a household consists of large number of cattle (58.1%) followed by goats (53.2%), sheep (45.3%) and camels 33.1% (IPS 2000).

Figure 4. *Cattle, goats and camels are important dairy animals in Mieso district.*

Table 6. *Overall species composition of herds in Mieso district*

Animal species	Number of households owning animals (No. = 120)	Number of animals	Ownership per household (mean ± SE)	Percentage from the total herd
Cattle	120	683	5.69 ± 0.35	42
Goats	113	723	6.03 ± 0.30	44
Camels	33	220	1.83 ± 0.92	14

SE = Standard error of mean.

The higher proportion of goats in the study area may be an adaptation strategy that households made for risk aversion to control bush encroachment effectively. This is in line with IPS (2000) report, which indicated that the species and herd composition of ruminant livestock in the lowlands depend on the agro-ecological condition of a particular area. Moreover, the variability and proximity of watering points as well as the proportion of browse to grasses are the determining factors. According to the respondents, the camel population has been decreasing over time due to tribal conflict and theft of animals.

3.3 Types of sources of income

Sales of milk and milk products and crops were the major sources of income for 96% and 95% of respondents, respectively. The majority (93%) of respondents indicated that sorghum and maize were the major cash crops in the area. As indicated in Table 7, the majority (95%) of respondents in Gena rural *kebele* were involved in crop sales as a major source of income. However, respondents in Gena rural *kebele* were least involved in off-farm activities (2%). This may be explained by the farming behaviour of the households who live near market sites. Most of the households who live around the market centre engage in milk and crop production. As a result, they are less dependent on off-farm activities as a source of income. The close proximity of households to market centres encourages them to sell available resources than searching for other off-farm activities such as daily labour, employment in *kebele* administration, sale of fire wood and charcoal and rural shop keeping.

In general, income from sale of animals was important for 60–74% of the respondents. Most of the households in all the rural *kebeles*, with the exception of Dire Kalu, generate substantial incomes from sale of milk and milk products. This may be due to the relative short distance to the market (3.9 km to the Asebot and 5.05 km to Mieso market). However, off-farm activities were equally important for all rural *kebeles*, except those in Gena *kebele*. Overall, 30% of the respondents indicated that engagement in off-farm

activity was an important source of income, and included sale of charcoal, firewood, employment in community leadership and rural shop keeping.

Table 7. *Major sales of products for household income generation among the rural* kebeles *in Mieso district*

	Sources for household income generation (%)							
	Crop sale		Live animal sale		Milk and milk products sale		Off-farm activity	
Rural *kebeles*	No.	%	No.	%	No.	%	No.	%
Dire Kalu	13	86.7	9	60.0	5	33.3	7	46.7
Gena	20	95.2	14	66.7	20	95.2	2	9.5
Huse Mendera	23	67.6	23	67.6	29	85.3	11	32.4
Hunde Misoma	18	66.7	18	66.7	26	96.3	11	40.7
Welda Jejeba	21	91.3	17	73.9	16	69.6	5	21.7
Overall	95	79.2	81	67.5	96	80.0	36	30.0

3.4 Animal management

3.4.1 Feeding management

All the respondents in the studied area indicated that cattle, camels and goats were fed principally on natural pasture or pasture on non-arable land maintained under rain-fed conditions. Kurtu (2003), on the other hand, indicated that only 72% of the rural livestock keepers in Harar area make use of natural pasture. Agricultural by-products such as crop residues, mainly obtained from sorghum and maize stover, and house waste are also used as feed sources. Feeding systems included communal or private natural grazing and browsing, and cut-and-carry system and stall feeding. The different types of feeds used in the study area are presented in Table 8.

Table 8. *Variations in additional feed resources used among rural* kebeles *in Mieso district*

		Type of additional feed sources										
	Total no. of respond-ents	Crop residue (Kera)		Mineral soil (haya)		Grain (sorghum)		Industrial by-product		Failed maize or sorghum (Chinki)		X^2 p-value
Rural *kebeles*		No.	%	No.	%	No.	%	No.	%	No.	%	
Dire Kalu	15	15	100	15	100	1	6.7	0	0	10	67	0.00
Gena	21	21	100	10	48	4	19.0	1	4.8	19	90	
Huse Mendera	34	34	100	12	35	2	5.9	1	2.9	30	88	
Hunde Misoma	27	27	100	2	7.4	10	37.0	2	7.4	27	100	
Welda Jejeba	23	23	100	9	39	1	39.0	0	0.0	15	65	
Total	120	120	100	48	40	18	15.0	4	3.3	100	83	

SE = Standard error of mean, No. = Sample respondents.

There were some improved forages (*Sesbania* and *Leuceana*) introduced into the crop–livestock production system, but there was no practice of supplementary feeding to animals using these forages. Similarly, as indicated by Beruk (2000), the use of improved forage and supplementary feed by pastoralists in Afar Region is insignificant; rather, the primary feed sources of livestock in the region were the rangelands composed of indigenous species of grasses, shrubs and fodder trees.

As indicated in Table 8, all the households use residues of sorghum and maize. Similarly, in the Harar milkshed, sorghum and maize are the major crops used in various forms for livestock feed (Kurtu 2003). However, sorghum stover is preferred to maize stover for dairy animals in the study area. The herders believe that feeding maize stover increases body weight rather than milk production. As a result, maize stover is used for fattening animals (mainly oxen), while sorghum stover is used as a major feed for dairy animals.

Traditionally, farmers in the study area grow sorghum and maize as fodder for livestock. Fodder from sorghum and maize is produced by intentionally oversowing above the recommended seeding rate as a strategy to produce fodder to feed their livestock through gradual thinning. The thinnings are locally called *'chinki'.* Eighty-three per cent of the respondents use *chinki* as a secondary feed resource followed by crop residues. Field observations and interview indicated that feeding of *chinki* for animals in a cut-and-carry system was the major task of female members of the household. In addition, farmers grow sweet sorghum exclusively for use as animal feed.

Soil salt, locally known as *haya*, is used by 40% of the respondents during the wet as well as the dry seasons. However, the respondents indicated that *haya* is used more frequently during the dry season to compensate for feed shortage. If water is available in the area, provision of *haya* in the dry season is preferable. *Haya* is fed by either trekking the animals to the salt area or by taking the salt to the homestead. All the respondents believed that the animals that lick salt get stronger during the dry season and lactating cows produce more milk. This is in agreement with the report of Abule et al. (2004) who indicated that in the middle Awash Valley, mineral salt feeding to cows is perceived to increase milk production. Only 3.3% of the respondents indicated that they use industrial by-products when milk production decreases or when animals become weak or sick. Some 15% of the farmers also provide boiled sorghum grain mixed with salt as supplementary feed to sick animals, milking animals, during the dry season, as well as to early postpartum cows. The awareness on the use of this type of additional feed source could be used to introduce other supplementary feeding strategies in the locality. In the crop–livestock mixed system, stall feeding is practised during the cropping season as all the farm land is covered by crops. Oxen and calves and sometimes milking and pregnant animals are tethered and fed around the household as other animals are moved to other areas for grazing.

The respondents also indicated that they practice feed conservation for dry season feeding. Feed is conserved in the form of what is locally known as *Kusa* (Figure 5), which is made by storing crop residue on the farm field (from sorghum only) in triangular form in an open system without any cover. This type of feeding is practised from crop-harvesting to end of the dry season. This storage system exposes the feed to moisture causing wastage through fermentation and insect pests. Due to the poor storage system, farmers often fail to get adequate conserved feed to take them up to the end of the dry season.

Figure 5. *Conservation of sorghum stover in the field (Kusa*).

3.4.2 Calf management

Young animals are managed in a traditional way. Nursing calves are kept separate from their dams, except when calves are used to stimulate milk letdown. Traditionally, calves are allowed to suckle two-quarters on the left side, while the other two-quarters are hand milked by women. This practice is believed to stimulate milk letdown. If the calf dies, the hide is stuffed with cereal straw or grass with four legs made of sticks. Salt is added to the hide of the stuffed calf and the dam is allowed to lick it in order to simulate the presence of the calf and stimulate milk letdown. Young children and females in general do most of the tending of small ruminants and calves near encampments. Management by female members of the family includes gathering cut-and-carry forages and hauling water for relatively immobile calves, which are kept in or near the family hut. Herders are well aware of colostrum feeding for the new born animals and understand the beneficial effect on health of the young.

The overall average weaning age of cattle and camel calves is 7.30 ± 0.17 and 10.60 ± 0.46 months, respectively (Table 9). However, weaning age is often determined by the season of birth of calves, the health status of the dam and the need for milk by the family. Complete weaning is practised when the dam ceases to lactate or becomes pregnant. This result agrees with the report of Coppock (1994) who reported weaning age of 7–12 months for Boran calves. If the dam is weak or gets ill, the farmers practice

forced weaning at an earlier age. Traditionally, the herders use different types of weaning methods. Weaning is performed by piercing the nose of the calf with thorns, twisting up the nose skin of the calves to prevent suckling (as this causes pain when the wounded nose touches the teat) and smearing of teats with animal dung.

Table 9. *Weaning age of cattle and camel calves in different rural* kebeles *in Mieso district*

	Weaning age (month)			
	Cattle calves		Camel calves	
Rural *kebeles*	No.	Mean ± SE	No.	Mean ± SE
Dire Kalu	15	7.00 ± 0.45	13	10.50 ± 0.55
Gena	21	6.70 ± 0.31	2	12.00 ± 4.72
Huse Mendera	34	8.30 ± 0.39	7	11.90 ± 0.63
Hunde Misoma	27	6.70 ± 0.17	8	10.90 ± 0.58
Welda Jejeba	22	7.10 ± 0.35	3	7.00 ± 3.21
Overall	119	7.30 ± 0.17	33	10.60 ± 0.46

SE = Standard error of mean, No. = Sample respondents.

Calves are provided with soil salt licks before they start feeding on forages. This is practised because it is generally believed that direct exposure of calves to forage immediately after cessation of milk feeding causes diarrhoea. On average around the first months (36 ± 2.12 days for cattle and 46 ± 6.02 for camel calves) of life, the calf diet consists of milk and a combination of cut-and-carry forage and calves are allowed to graze around the encampment. The amount of milk that a calf receives varies with season and the human demand for the milk.

3.4.3 Milking management

Traditional hand milking is the only type of milking practised in the whole district. Washing of teats before milking is not practised and the producers believe that during calf suckling for milk letdown, the teats get washed by the saliva of calf and therefore it is not as such important to wash the teats before milking. Labour division for milking was, however, dependent on the species of the animal milked. Milking of cows and goats is mainly done by women, while milking of camels is commonly done by men. Traditionally calves are allowed to suckle their dams before (to initiate milk letdown) and after milking (to drain whatever is left in the udder).

As indicated in Table 10, cows are milked once or twice a day whereas camels are milked between one and six times a day depending on the season. If a calf seems weak or becomes ill, its dam will be milked less frequently and the amount of milk taken on each occasion will be reduced. Almost all of the households indicated that in case of cow milking, twice milking is a common practice in the wet season. However, milking

frequency decreases to once a day in the evening during the dry season (Table 10). Milking frequency in the area also depends on feed availability. Evening milking in the dry season is practised because cows are kept far from the homestead for grazing during the daytime. Milk produced in the evening is kept in properly washed and smoked utensils and marketed in the next morning.

Table 10. *Variation of responses on milking frequency of cows and camels in different seasons at Mieso district*

Rural *kebeles*	Milking frequency of cow per day							Milking frequency of camel per day										
	Wet season		Dry season					Wet season						Dry season				
	Twice		Once		Twice		X^2 P-value	Twice		Thrice		Six times	X^2 P-value	Once		Twice		Thrice		X^2 P-value
	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Dire Kalu	15	100	14	93	1	6.7		1	7	5	33	2	13	5	33	4	27	9	60	
Gena	21	100	21	100	0	0		2	10	0	0	0	0	0	0	0	0	0	0	
Huse Mendera	34	100	34	100	0	0		0	0	7	21	0	0	1	0	3	8.8	4	12	
Hunde Misoma	27	100	27	100	0	0	0.32	0	0	10	37	0	0	0.00	0	0	1	3.7	9	33	0.00
Welda Jejeba	23	100	22	96	1	4		4	17	1	4	1	4.3			4.3	1	4.3	2	9	
Total	120	100	118	98	2	2		7	6	23	19	3	2.5	7	5.8	9	7.5	24	20	
Mean	2		1.00					2.7						2.4						

No. = Sample respondents.

Out of the total camel owners, 72% of the respondents in study area indicated that camels are milked up to thrice a day during the wet and the dry seasons (Table 10). However, the average milking frequency in the dry season is twice a day while thrice is common during the wet season. This result is similar to the report of Tezera and Bruckner (2000) who indicated that milking frequency of camels in Somali Region is thrice per day and twice per day during the wet and the dry season, respectively. Some camel holders practice six times a day, milking depending on the season, stage of lactation and the household needs for milk. This was practised during the wet season and /or during the early stage of lactation.

3.5 Productive and reproductive performance

3.5.1 Milk yield

As indicated in Table 11, the average cow milk yields/head per day during the first, second and third stages of lactation were 1.37 ± 0.02 litres, 1.86 ± 0.03 litres and 0.49 ±

0.01 litres, respectively. The overall cow milk yield/head per day was 1.24 ± 0.02 litres. This value is comparable with the national average of 1.54 litre/day per cow (CSA 2008). Lemma et al. (2005) also reported that the average milk yield of local Arsi cows was 1.0 litre/cow per day. There were variations among rural *kebeles* in daily milk yield/head, which is highest ($P < 0.05$) for cows in Hunde Misoma (1.48 ± 0.06 litres) and the least in Gena rural *kebele* (1.03 ± 0.04 litres).

Table 11. *Milk yield performance of cows in different stages of lactation at different rural* kebeles *in Mieso district*

Rural *kebeles*	Daily milk yield per head (litres)							
	Stage of lactation							
	First		Second		Third		Overall	
	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE
Dire Kalu	60	1.41 ± 0.04	40	1.81 ± 0.04	15	0.49 ± 0.03	15	1.28 ± 0.03
Gena	65	1.42 ± 0.06	55	1.81 ± 0.08	35	0.43 ± 0.02	35	1.05 ± 0.04
Huse Mendera	110	1.38 ± 0.03	215	1.78 ± 0.03	95	0.51 ± 0.02	95	1.23 ± 0.02
Hunde Misoma	40	1.43 ± 0.08	55	2.24 ± 0.09	35	0.49 ± 0.02	35	1.48 ± 0.06
Welda Jejeba	105	1.28 ± 0.04	25	1.87 ± 0.08	10	0.49 ± 0.05	10	1.24 ± 0.05
Average	380	1.37 ± 0.02	390	1.86 ± 0.03	190	0.49 ± 0.01	190	1.24 ± 0.01
P value		0.123		0.00		0.125		0.00

SE = Standard error of mean, No. = Sample milking cows.

The average lactation milk yield per cow was estimated to be 271.4 litres over an average lactation period 7.29 ± 0.17 months (Table 11). Higher average milk yield of 488 litres over a lactation period of 249 days for local cows found in Somali Region was reported (IPS 2000). Mukasa-Mugerwa et al. (1989) noted that Zebu cattle under traditional management in general yielded about 524 litres over a 239-days lactation. The low lactation milk yield found in the current study may be due to poor genetic make up of the animals for milk production, shortage of feed, shorter lactation length and/or poor management conditions.

Table 12 shows the estimated average daily milk yield for camels during the first (2.4 ± 0.07 litres), second (3.11 ± 0.08 litres) and third (1.36 ± 0.03 litres) stages of lactation. The overall estimated average camel milk yield per head per day was 2.4 ± 0.06 litres. Estimated average lactation yield was 797 litres over an average lactation length of eleven month. This result is similar to the report of Tefera and Gebreab (2001) who recorded an average daily milk yield of camels in eastern Ethiopia to be 2.5 litres per day over a lactation period of one year. However, the current results are lower than the values reported by Baloch (2002) who found an average milk yield and lactation length of 1894.9 litres and 445.6 days, respectively, for camels in Pakistan. The shorter lactation

period and lower lactation milk yield found in this study may be due to feed shortage in the area or due to breed differences.

Table 12. *Milk yield performance of camels in different stages of lactation at different rural* kebeles *in Mieso district*

	Daily milk yield per head (litre)							
	Stage of lactation							
	First		Second		Third		Overall	
Rural *kebeles*	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE
Dire Kalu	40	2.58 ± 0.09	25	3.31 ± 0.17	10	1.47 ± 0.10	75	2.68 ± 0.10
Gena	5	1.50 ± 0.11	5	3.68 ± 0.29	10	1.55 ± 0.04	20	2.07 ± 0.23
Huse Mendera	15	2.71 ± 0.17	20	3.57 ± 0.17	4	1.44 ± 0.12	39	3.02 ± 0.15
Hunde Misoma	14	1.85 ± 0.08	45	2.72 ± 0.09	21	1.36 ± 0.09	80	2.21 ± 0.09
Welda Jejeba	11	2.44 ± 0.19	6	3.29 ± 0.62	35	1.29 ± 0.04	52	1.76 ± 0.12
Overall	85	2.41 ± 0.07	101	3.11 ± 0.08	80	1.37 ± 0.03	266	2.36 ± 0.06
P value		0.00		0.00		0.139		0.00

SE = Standard error of mean. Sig. = Significant value, No. = Sample milking camels.

3.5.2 Lactation length

Indigenous breed of cows, although are generally considered as low milk producers, they are the major source of milk in the study area. The lactation length of animals in the study area depended mostly on the management objective of the herder; the herder may prolong the lactation length for the sake of continuous milk supply to the household or dry off the cow at early stage of lactation for breeding purpose. As indicated in Table 13, the average lactation length for cows was 7.29 ± 0.17 months. This agrees with the report of CSA (1996) who indicated that an average lactation length of cows in private holdings ranged from 5–7 months. However, the current result is lower than the 9.5 months reported by Lemma et al. (2005) for local cows in the East Showa Zone of Oromia Region in Ethiopia.

The average lactation length of cows agrees with the 212 days reported for local cows by Kurtu (2003) in the Harar milkshed. However, the result obtained contradicts with the result reported by Semenye (1987) who reported an average lactation length of 12 months for cows in Maasai pastoral area. This shorter lactation length in the current study may be due to the purposive early drying-off of cow that the herders practised.

Table 13 shows that the mean (± SE) lactation length for camels was 11.25 ± 3.18 months and there were no differences among the rural *kebeles*. Tefera and Gebreab (2001) reported that the average lactation period of camels in eastern Ethiopia in general was one year. Tezera and Bruckner (2000) also reported that lactation length of camels in

Jijiga and Shinile zones in Ethiopia was 15 and 13 months, respectively. Similarly, Baloch (2002) reported an average lactation length of 445.6 days for camels in Pakistan. The present result is also within the range of 8 months to 2 years reported for East African camels by Schwartz and Dioli (1992).

Table 13. *Lactation length of cows and camels in different rural* kebeles *in Mieso district*

Rural *kebeles*	Lactation length					
	Cows			Camels		
	No.	Mean ± SE	P value	No.	Mean ± SE	P value
Dire Kalu	15	6.93 ± 0.44		13	10.38 ±0.55	
Gena	20	6.70 ± 0.63		2	10.50 ± 1.50	
Huse Mendera	34	8.29 ± 0.39	0.002	7	14.00 ±1.95	0.143
Hunde Misoma	27	6.74 ± 0.17		7	10.71 ±0.64	
Welda Jejeba	23	7.22 ± 0.34		3	10.33 ±1.67	
Overall	119	7.29 ± 0.17		32	11.25 ± 0.56	

3.6 Mortality

As indicated in Table 14, the overall percentage of pre-weaning mortality for goats, cattle and camels was 41.7 ± 8.00, 61.7 ± 5.20 and 66.7 ± 14.70, respectively. The differences in mortality rates between the species were largely a reflection of management techniques used by the herders and the ability of each species to resist/tolerate diseases and stressful conditions. However, the percentage post-weaning mortality was lower than the pre-weaning mortality. The respective percentages of post-weaning mortality were 27.6 ± 6.60, 32.6 ± 4.40 and 23.50 ± 0.83 for goats, cattle and camels, respectively. The lower post-weaning mortality could be due to improved management provided to young animals kept in and around the homestead for up to one year of age. During this period, calves rely exclusively on wet leaves or grasses that are provided mostly by the female members of the household. The current result is also in agreement with the reports of Gebre-egziabiher et al. (1991) who indicated that with an increase in age, mortality decreased probably because of improved adaptation of animals to both climatic and nutritional factors. The overall mortality for the cattle herd was 43.7 ± 5.20. Wagenaar et al. (1986) reported that in Fulani cattle herds, pre-weaning calf mortality up to one year age was 43%, and decreased to 7.5% during the post weaning period. These high losses have invariably been attributed to poor young management practices and/or poor veterinary services.

Table 14. *Pre-weaning and post-weaning mortality (%) of animals based on owners response in Mieso district*

Animal species	Average mortality				Overall mean
	Pre-weaning		Post-weaning		
	No.	Mean ± SE	No.	Mean ± SE	
Cattle	27	61.7 ± 5.20	41	32.6 ± 4.40	43.7
Goat	10	41.7 ± 8.00	14	27.6 ± 6.60	30.0
Camel	12	66.7 ± 14.70	10	23.5 ± 0.83	35.3

SE = Standard error of mean, No. = sample households who encountered loss in dairy animals due to diseases.

As indicated in Table 15, mortality due to diseases was the major (65%) cause of loss in all the species of animals followed by drought (15%), abortion (7%) and predators (7%). The least cause of animal death was poisoning (5%). The major cattle, goats and camel killer diseases reported by herders in the study area were anthrax, FMD, diarrhoea, blackleg, pasteurollosis, respiratory tract infections and internal and external parasites. Similarly, as a report from the Maasai pastoralist indicated, the major cause of death for young (76%) and adult (54%) goats was diseases followed by predator (11%) and physical injury (4%) (Grandin et al. 1991).

Table 15. *Major causes of death of cattle, camels and goats in Mieso district*

Reason of death	Number and percentages of animals lost						Total	
	Cattle		Camel		Goats			
	No.	%	No.	%	No.	%	No.	%
Diseases	44	64.7	8	66.7	16	66.7	68	65.0
Drought	15	22.0	0	0.0	1	4.2	16	15.4
Poisonous herbs	2	2.9	2	16.6	1	4.2	5	4.8
Abortion	4	5.9	1	8.3	2	8.3	7	6.7
Accident/predators	3	4.4	1	8.3	3	12.5	7	6.7

3.7 Gender roles in dairy animal production

Data on roles of men and women members of the household in animal management are presented in Table 16. Of the households who had milking cows during the study period, 97.5% indicated that milking cows is the responsibility of only female members of the household. Only 2.5% of the respondents indicated that males take part in milking activity if the cow is aggressive and the woman is unable to easily handle animal or if the woman is too busy with other activities.

Table 16. *Gender roles in animal management*

Activity	Total HH	Household member					
		Female		Male		Both	
		No.	%	No.	%	No.	%
Herding and watering	120	110	91	120	100	110	91
Barn cleaning	120	120	100	0	0	0	0
Milking (cows)	120	120	100	0	0	3	2.5
Milking (does)	120	120	100	0	0	0	0
Milking (she camels)	120	0	0	120	0	0	0
Milk marketing	120	120	0	0	0	0	0
Live animal marketing	120	10	8	40	33	70	58
Feed collection	120	1	0.8	107	89	12	10

Division of labour in the household for feed collection depends on the availability of feed around the homestead. According to 89.2% of the respondents, if feed is not available in the area, it is evident that feed collection is the sole responsibility of the male members of the households. However, 10.8% of the households indicated that if there are young animals around the homestead, the task of feed collection is shared with women. In this case, women take all the responsibility to cut and carry thinnings of sorghum and maize (*chinki*) and to collect stover from the field to feed calves that stay around the homestead and also for other animals to feed at night when they return from grazing. This agrees with the findings of Coppock (1993) who reported that in Borana, responsibilities of women includes gathering cut-and-carry forage and hauling water for relatively immobile calves.

Milk marketing is a specialized activity for female members of the household. This is similar to the reports from the Borana plateau that milk processing and marketing is under the control of women (Coppock 1994). Out of 97.5% of the households who sell milk, 58% indicated that milk and milk product marketing starts when young girls reach the age of 10 years. Regarding marketing of live animals, about 58.3% of the households indicated that it is the responsibility of both men and women, while 33.3% of the households indicated that only male members of the family are responsible for this task.

3.8 Milk consumption and marketing

3.8.1 Milk consumption

The primary objective of keeping cows, camels and goats in the study area was for milk production. Fresh milk, fermented milk, whey, and butter were among the common milk products produced and consumed. However, local cheese (*ayib*) was not produced

among the surveyed households. Culturally fermented milk is not sold; rather cow fresh whole milk, butter, camel milk and rarely goat milk are sold in the market.

Variation among rural *kebeles* in milk consumption patterns from different species of dairy animals is presented in Table 17. Cow milk consumption is a common practice in the district and is generally used by 82.5% of the respondents. Camel and goat milk is consumed by 9.2% and 8.3% of the respondents, respectively. According to the respondents, priority in milk consumption is given to the husband, guests, children and then the wife, sequentially. Traditionally, milk is consumed in the household in the form of *'hoja'*—a drink that is prepared from goat, camel and rarely from cow milk by mixing it with water and coffee husk and boiling it. Goat milk is the most preferred for *hoja* making. It is a traditional drink that is given to guests as well. Children are the major consumers of goat milk in the household. Goat milk is often sold at the farm gate or contracted to neighbours for feeding children. It is believed that children who drink goat milk grow well and become healthy. Goat owners reported that goat milk is also used to cure wounds by mixing it with different herbs.

Table 17. *Household milk consumption pattern (percentage) in Mieso district based on the species of dairy animals*

Fresh milk	Dire Kalu (No. = 15)		Gena (No. = 21)		Huse Mender (No. = 34)		Hunde Misoma (No. = 27)		Welda Jejeba (No. = 23)		Total (No. = 120)		X^2 P-value
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Cow	13	87	20	95.0	29	85.3	23	85.2	14	60.9	99	82.5	0.047
Camel	2	13	0	0.0	3.0	8.8	3	11.1	3	13.0	11	9.2	
Goat	0	0.0	1	5.0	2.0	5.9	1	3.7	6	26.1	10	8.3	

(No.) = Total number of respondents, No. = Sample respondents.

As presented in Table 17, about 83% of the respondents indicated that priority is given for cow milk consumption rather than selling it in the market. This may be due to the importance of the by-products (butter and fermented milk) one gets from the processed cow milk.

3.8.2 Milk marketing

As presented in Table 18, the majority of the households sell whole milk (78%) and butter (67%). Some 4.2% of the respondents also reported that they sell whey. There were variations among the rural *kebeles* in the sale of fresh milk, butter and whey, but there was no difference in sales of products between male and female-headed households.

About 22% of the households indicated that cow milk is produced and used for home consumption only. However, 78% of the respondents indicated that milk is produced for home consumption as well as for marketing.

Table 18. *Type of milk and milk products sold by households in the different rural* kebeles *in Mieso district*

Rural *kebeles*	Total no. of respondents	Milk and milk product sale						X^2 P-value
		Fresh milk		Whey		Butter		
		No.	%	No.	%	No.	%	
Dire Kalu	15	5	33	0	0.0	7	47	0.00
Gena	21	19	90	1	4.8	19	90	
Huse Mendera	34	28	82	3	8.8	23	68	
Hunde Misoma	27	26	96	1	4.8	15	56	
Welda Jejeba	23	16	70	0	0.0	16	70	
HH sex								0.63
Female	27	21	78	2	7.4	18	61	
Male	93	73	78	3	3.2	62	67	
Total	120	94	78	5	4.2	80	67	

HH sex = Household head sex, No. = Sample respondents.

About 72% of the respondents indicated that cow milk is sold both during the dry and wet seasons. However, 8.3% of the respondents sell milk during the wet season only. Participation of the majority of the households in milk marketing shows that dairying is an important source of household income. The proportion of households that participate in milk marketing during both the dry and wet seasons was higher ($P \leq 0.05$) in Hunde Misoma (93%) and Gena (86%) rural *kebeles* than the other rural *kebeles*. This may be due to the close proximity of these rural *kebeles* to the Asebot and Mieso markets. This result is similar with the report of Coppock (1994) in the Borena plateau who reported that only households close to markets were able to sell milk more frequently.

As shown in Table 19, overall 29% and 63% of the households market only one-fourth of the milk during the wet and dry season, respectively, while the respective values for marketing 50% of the produce were 71% and 5%. A high percentage of respondents (78%) indicated that the amount of milk sale increases during the wet season. This increase in milk yield and supply to the market is mainly due to more cows calving in the wet season and increased feed availability. However, milk price decreases during the wet season due to increases in supply.

Table 19. *Seasonal variations in marketed whole cow milk in different rural* kebeles *in Mieso*

Rural *kebeles*	Total no. of respondents	No.	Cow milk marketed (out of total herd milk off-take per household per day)							
			Wet season				Dry season			
			One-fourth		Half		One-fourth		Half	
			No.	%	No.	%	No.	%	No.	%
Dire Kalu	15	5	0	0.0	5	100	1	33	2	67
Gena	21	19	3	16	16	84	17	94	1	5.6
Huse Mendera	34	27	7	26	21	78	23	92	1	4.0
Hunde Misoma	27	26	11	42	15	58	25	100	0	0.0
Welda Jejeba	23	16	6	38	10	63	10	83	2	17
X^2 P-value			0.00				0.00			
Total	120	94	27	29	67	71	76	63	6	5.0

No. = Sample respondents.

According to the response of the producers, the average cow milk yield/head per day in the wet and dry season was 3.26 ± 0.07 and 1.63 ± 0.04 litres, respectively. This variation is mainly due to differences in feed supply. There is a clear indication that whenever there is excess milk in the household, farmers in the area are able to participate in milk marketing. However, respondents indicated that mostly the morning milk marketed and the evening milk is often used for home consumption. This result is contrary to the report of Coppock (1994) in Borena who indicated that out of the total milk yield, 66% is consumed at the household and 24% is sold or given to other households.

As shown in Table 20, there were variations among rural *kebeles* in cow milk yield/head per day in the wet season, and values ranged from 2.60 ± 0.21 litres in Dire Kalu to 3.68 ± 0.12 litres in Huse Mendera. The overall average cow milk production/household per day in the wet and the dry seasons was 4.80 ± 0.22 and 2.37 ± 0.11 litres, respectively. In the wet season, significantly ($P \leq 0.05$) higher cow milk yield per head was estimated in Huse Mendera (3.68 ± 0.12 litres) than in Dire Kalu rural *kebele* (2.60 ± 0.21 litres). Cow milk yield per household in the wet season in the Welda Jejeba (6.2 ± 0.69) and Dire Kalu (5.80 ± 0.75) *kebeles* were higher than the other three rural *kebeles*.

In the dry season, cow milk production per household was the lowest in Dire Kalu (1.43 ± 0.15) than in the other rural *kebeles*. This may be due to the relatively higher amount of milk left for calves to suckle. Milk production per household in the dry season was similar in Dire Kalu (3.10 ± 0.38) and Welda Jejeba (3.08 ± 0.35), and these estimates were the highest compared to the other rural *kebeles*. The average amount of cow milk sold per household during the wet (3.60 ± 0.28) and the dry (2.20 ± 0.22) seasons did not differ between rural *kebeles*.

Table 20. *Estimated amount of cow and camel milk produced and marketed in wet and dry seasons in Mieso based on producer response*

Rural *kebeles*		Cow milk						Camel milk					
		Litres produced/ head		Litres produced/ household		Litres sold/ day per household		Litres produced/ head		Litres produced/ household		Litres sold/day per household	
		Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Dire Kalu	Mean	2.60	1.43	5.80	3.10	2.80	2.00	7.92	4.04	17.04	8.7	4.3	3.5
	No.	15	15	15	15	5	2	13	13	13	13	3	2
	SE	0.21	0.15	0.75	0.38	0.37	1.00	1.02	0.51	2.56	1.32	0.67	0.50
Gena	Mean	3.07	1.43	4.10	1.80	3.00	1.55	5.44	3.5	10.6	6.2	0.00	0.00
	No.	21	21	20	20	19	19	2	2	2	2	0.0	0.0
	SE	0.18	0.13	0.41	0.18	0.25	0.15	0.00	0.13	0.11	0.00	0.0	0.0
Huse Mendera	Mean	3.67	1.89	4.18	2.16	4.03	2.98	10.93	4.71	18.36	7.57	4.00	2.00
	No.	34	34	34	34	29	28	7	7	7	7	4	4
	SE	0.12	0.07	0.24	0.13	0.64	0.61	1.96	0.75	4.51	1.51	0.82	0.41
Hunde Misoma	Mean	3.26	1.57	4.33	2.07	4.22	2.17	7.30	3.70	8.00	4.00	2.62	2.47
	No.	27	27	27	27	25	26	10	10	8	8	7	7
	SE	0.15	0.09	0.36	0.17	0.67	0.32	0.51	0.26	0.85	0.42	0.66	0.67
Welda Jejeba	Mean	3.24	1.59	6.24	3.08	2.55	1.33	10.50	5.33	25.00	12.67	4.67	3.00
	No.	23	23	23	23	17	15	3	3	3	3	3	3
	SE	0.14	0.07	0.69	0.35	0.38	0.13	1.50	0.67	6.08	2.90	1.46	1.16
X^2 p-value		0.00	0.001	0.002	0.00	0.217	0.81	0.148	0.349	0.032	0.015	0.318	0.692
Overall	Mean	3.26	1.63	4.80	2.37	3.55	2.15	7.12	3.85	13.19	7.63	3.61	2.58
	No.	120	120	119	119	94	90	33	33	31	31	17	16
	SE	0.07	0.04	0.22	0.11	0.28	0.22	0.33	0.20	0.95	0.82	0.45	0.37

No. = Sample respondents.

Camel milk yield/head per day during the wet (7.10 ± 0.33 litres) was higher than during the dry (3.80 ± 0.20 litre) season. The average camel milk produced per household per day in the wet (13.19 ± 0.95 litres) and the dry (7.62 ± 0.82 litres) seasons also differed among the rural *kebeles*. The lowest camel milk produced per household was observed in Gena rural *kebele*. This may be due to the few number of observations or the limited pasture availability in the area. The higher milk production per household in Welda Jejeba may be due to the higher number of holdings of lactating camels. Nevertheless, there were no variations among rural *kebeles* in the amount of camel milk sold per household in the wet (3.61 ± 0.45 litres) and the dry seasons (2.58 ± 0.37 litres).

There were seasonal differences between the amounts of cow and camel milk produced and sold. The average cow and camel milk sold per household per day in the wet season was 3.55 ± 0.28 and 3.61 ± 0.45 litres, respectively. Huse Mendera rural *kebele* had the

highest supply of cow milk to the market in both the wet as well as the dry season than the other rural *kebeles*. However, there was no significant (P>0.05) seasonal variation in milk sale between male and female headed households. In the dry season, this volume decreased by 39% to 2.15 ± 0.22 and by 28% to 2.58 ± 0.37 litres, respectively. This indicates that sale of camel milk decreases at a relatively lower rate than cow milk sale during the dry season. In agreement with an earlier report of Zeleke (1998), this may be due to the fact that camels can survive and still continue to produce some milk during the dry season and have relatively longer lactation length than cows. In the study area contrary to other pastoral areas, as cow milk production per household increased, there was also an increase in milk sales. In the lowlands of Borana, whenever there was a seasonal increase in milk production in the household, there was a tendency to increase household consumption rather than milk marketing (Coppock 1994).

As indicated Table 21, the amount of cow milk sold per day in Mieso was higher than in Asebot market for cow (496.57 ± 19.12 litres vs. 343.34 ± 19.22 litres), while it did not differ for camel milk (187.89 ± 19.12 litres vs. 193.28 ± 19.22 litres). This is probably due to the fact that Mieso market is more central for more rural *kebeles*. In addition, Mieso town is the district's capital, where there is more demand for cow milk. Personal observations and interviews with producers, farmers and pastoralists found out that cow milk is also supplied to Mieso market by pastoralists from the adjacent district of Mullu of the Somali Region. The prices of cow and camel milk did not differ between the two markets

3.8.3 Milk marketing system

Marketing of milk in the Mieso district was mainly a traditional type. There were two different milk outlets identified; namely traditional milk associations or groups and the producer themselves (individual seller). The traditional milk producer associations or group are locally called *Faraqa Annanni*. These are self-organized groups, which involve women who have milking cows and/or camels. The number of women that participate in *Faraqa Annanni* ranges from 2 to 10 per group. Members are organized on the basis of selling whole fresh cow and/or camel milk.

From the total (n = 94) households who sell milk, only 22 (23%) were involved in the milk seller groups. This indicates that the majority of the households' sell milk on individual basis. As a result, cash income from milk sales is used to cover daily expenses. In the *Faraqa Annanni* (milk marketing group), members contribute an agreed amount of milk on a weekly basis and this is allocated to an individual woman on a shift basis. The woman sells the milk and the daily income belongs to her. The cycle continues until every member gets her share of the milk income. This system has several advantages.

It saves time and labour (as they go to market once or twice a week depending on the group size) and it also helps the women to save money since they generate income on a weekly or monthly basis.

Table 21. *Seasonal variations in quantity and price of cow and camel milk sold in Mieso and Asebot markets*

Variables	Market	Milk type	Seasonal milk sale	Mean ± SE	95% confidence interval	
					Lower bound	Upper bound
Amount of milk sold, litres	Asebot	Cow	Wet season	473.30 ± 27.336	418.31	528.30
			Dry season	213.38 ± 27.044	158.97	267.78
		Camel	Wet season	243.13 ± 27.336	188.13	298.12
			Dry season	143.43 ± 27.044	89.02	197.83
	Mieso	Cow	Wet season	629.29 ± 27.044	574.88	683.69
			Dry season	363.86 ± 27.044	309.45	418.26
		Camel	Wet season	180.71 ± 27.044	126.31	235.12
			Dry season	195.07 ± 27.044	140.67	249.48
Price, ETB[a]/ litre	Asebot	Cow	Wet season	1.94 ± 0.147	1.64	2.24
			Dry season	3.14 ± 0.146	2.85	3.44
		Camel	Wet season	1.42 ± 0.147	1.12	1.71
			Dry season	2.96 ±0.146	2.67	3.26
	Mieso	Cow	Wet season	1.82 ± 0.146	1.53	2.12
			Dry season	3.61 ± 0.146	3.31	3.90
		Camel	Wet season	1.86 ± 0.146	1.56	2.15
			Dry season	3.00 ± 0.146	2.71	3.29

SE = Standard error of means. a. ETB (Ethiopian Birr). In November 2008, USD 1 = ETB 9.75.

Producers reported that the disadvantages of *Faraqa Annanni* is the reduction in the number of membership when cows dry up, adulteration of milk by adding of water, no risk sharing among the members if milk was not sold on a particular day, and cheating among group members by selling milk without their turn (due to absence of proper recording). Price of milk is also determined more by the consumers than the producers. Consumers influence price depending on the season. Consumers communicate amongst themselves when they come to the market before purchasing milk and dictate prices. Seasonal price fluctuations and consumer interference in price setting are the two major problems in milk marketing in the district. These problems associated with traditionally managed milk groups should be studied and solutions need to be sought to make them more efficient and effective.

There were variations among the rural *kebeles* for not participating in milk marketing groups (Table 22). The major reason for lack of group marketing for 44%, 32% and 25% of the respondents in Hunde Misoma, Huse Mendera and Gena rural *kebele*s,

respectively, was the small quantity of milk produced per household. For 35% of female-headed households, the relatively small quantity of milk produced hinders their participation in group marketing. The absence of organized milk marketing group was raised as a problem by all and 75% of the respondents in Dire Kalu and Welda Jejeba rural *kebeles*, respectively. The need for daily income from sale of milk was also identified as a reason for not participating in *Faraqa Annanni* by 50 and 37% of the respondents in Gena and Huse Mendera rural *kebeles*, respectively. About 24% of the women-headed households also indicated that the cash need on a daily basis to cover household expenses was a major reason for not participating in group marketing. In general, 39% and 32% of the households indicated that the absence of *Faraqa Annanni* and the small quantity of milk produced, respectively, were the major reasons for not being involved in milk marketing group. Participation of households around the market centre is more influenced by the availability of *Faraqa Annanni* in their village.

Table 22. *Major reasons for non-participation in* Faraqa Annanni *in Mieso district*

Variables	Total no. of respond-ents	Low milk quantity		Prefer to be processed		Always go to market to sell or buy other materials[1]		No *Faraqa Annanni* organized in the area		Income need on daily basis		X^2 P-value
Rural *kebeles*		No.	%	No.	%	No.	%	No.	%	No.	%	
Dire Kalu	5	0	0.0	0	0.0	0	0.0	5	100	0	0.0	
Gena	16	4	25	0	0.0	3	19	1	6	8	50	
Huse Mendera	19	6	32	2	11.0	0	0.0	4	21	7	37	0.00
Hunde Misoma	16	7	44	0	0.0	1	6.0	6	38	2	13	
Welda Jejeba	16	4	25	0	0.0	0	0.0	12	75	0	0.0	
HH sex												
Female	17	6	35	0	0.0	1	6.0	6	35	4	24	0.167
Male	55	17	31	2	4.0	3	5.0	22	40	11	20	
Total	72	23	32	2	3.0	4	6.0	28	39	15	21	

1. Indicate women involved in other business and go to market every day, HH sex = Household head sex, HH = Household, (No.) = Total number of respondents, No. = Sample respondents.

The average amount of milk sold by an individual (1.64 ± 0.06 litres/person per day) was lower ($P<0.05$) than those in a group (3.93 ± 0.18 litres/person per day). The total amount of milk sold per person per day at Mieso (3.27 ± 0.17 litres) was higher ($P<0.05$) than at Asebot market (1.91 ± 0.06 litres). The number of individuals who participate in a *Faraqa Annanni* per day did not differ between Asebot (2.94 ± 0.13) and Mieso (3.05 ± 0.22) markets. However, there was more number of marketing groups in Mieso than in Asebot.

This may be due to the involvement of milk marketing groups from adjacent district of Somali Region who are predominantly pastoralists.

Constraints to milk marketing

The major constraints in milk marketing identified by the producers are insufficient amount of milk production (73%), long distance to market (38%), spoilage (19%), high cost of transport (12%) and cultural limitation (8%). As shown in Table 23, the mean (± SE) distance women travel to sell milk was 5.89 ± 0.19 km, and ranged from 1 to 12 km. The long distance to market in Dire Kalu rural *kebele* has reduced participation in milk marketing. Cultural taboo in milk marketing was found to be a minor problem in the district, indicating the existence of an opportunity for market-oriented dairy development in the area. In East Showa Zone of Oromia Region, Lemma et al. (2005) reported that insufficient amount of milk production per household and cultural restrictions were the most important factors that hindered milk marketing. Similarly, Alganesh (2002) reported that about 21% and 19% of women in eastern Wollega do not sell fresh milk due to scarcity of milk at the household and cultural restriction, respectively.

Table 23. *Distance travelled per day (km) to sell milk and milk products*

Rural *kebeles*	No.	Mean + SE	Minimum	Maximum	P value
Dire Kalu	7	9.29 ± 0.57	8.0	12.0	
Gena	19	5.05 ± 0.12	4.0	7.0	
Huse Mendera	30	6.23 ± 0.26	4.0	10.0	0.000
Hunde Misoma	26	3.92 ± 0.22	1.0	8.0	
Welda Jejeba	18	7.7 ± 0.11	7.0	8.0	
HH sex[a]					
Female	22	6.0 ± 0.46	3.0	12.0	0.743
Male	78	5.9 ± 0.21	1.0	10.0	
Total	100	5.9 ± 0.19	1.0	12.00	

a. HH sex = household head sex.

Constraints in milk marketing faced by producers among rural *kebeles* were different. Small milk quantity was equally important in Gena, Huse Mendera, and Hunde Misoma rural *kebeles,* while this was less important for respondents in Dire Kalu, probably due to higher number of animal holdings per household than the other rural *kebeles*. Distance to market (80%), cultural restriction (20%), high transport cost (7%) and spoilage (13%) were the major constraints in Dire Kalu than in other rural *kebeles*.

The major limiting factors for market participation can be alleviated by providing appropriate technologies for enhancing utilization of available feed resources, development of feed resources and range management system and improved animal health and reproductive management to ensure increased milk production throughout the year. Distance to the market can be dealt with by using animals or by introducing animal drawn carts for milk collection and transport from remote areas. But all these need interventions to develop infrastructure for input supply, enhanced use of animal power, capacity development and training to enhance the skills of farmers in dairy production, processing and marketing.

3.9 Constraints to dairy production

According to the respondents, there were different challenges in dairy production in the district. These include shortage of forage and pastureland, shortage of water, security problem, access to transport, inadequate access to veterinary drugs and services, lack of improved dairy animals, unavailability of credit services, inadequate extension service and lack of knowledge and skills (Table 24). Among these problems, feed scarcity, water shortage, security problem, and limited access to veterinary services were the major problems identified by 41%, 30%, 14.5% and 8% of the household, respectively. Shortages of forages and pasture and water were equally important to 32% of the respondents in the study area. About 30% of the respondents indicated that veterinary service is a serious problem in all the rural *kebeles*. This is due to irregular visit by the veterinarians, shortage of experts and lack of transport. Similarly, Jabbar et al. (1997) indicated that shortage of feed and water are major problems in all traditional livestock production systems that are characterized by low input, feeding and management requirements and the use of indigenous genotypes.

Security problem in the area is the most unregulated factor that has forced herders to lead unstable life. Tribal conflict among the Oromo, Afar and Somali people is mainly due to competition for land use. Conflicts arise during crossing of the different ethnic boundary for use of available pasture. The problem is exacerbated during the dry and the main rainy seasons. Between July and September when most of the land is covered with crops, pastoralists from Afar and Somali regions come to the district with their animals to utilize the available pasture, resulting in conflict. Right after harvest of crops in the dry season, crop–livestock producers get into conflict with pastoralists who forcefully use the crop residues. Traditional systems of conflict resolution are undertaken among tribal leaders. However, it is a continuing problem in the community hindering development activities in the district.

Table 24. *Ranking of problems associated with dairy animal production in Mieso district*

Problems	Total no. of respond-ents	Priority of problems in dairy animal production							
		1st		2nd		3rd		4th	
		No.	%	No.	%	No.	%	No.	%
Forage and pasture shortage	120	51	41.0	40	32.0	17	14.0	7	6.0
Water shortage	120	37	30.0	40	32.0	10	8.0	9	7.0
Security problem	120	18	15.0	11	9.0	29	23.0	29	23.0
Poor access to vet. services	120	10	8.0	12	10.0	39	31.5	37	30.0
Lack of transport	120	4	3.0	4	3.2	14	11.3	19	15.0
Lack of improved dairy breeds	120	0	0.0	13	11.0	11	8.9	12	10.0
Absence of credit service	120	0	0.0	0	0.0	0	0.0	1	0.8
Poor extension service	120	0	0.0	0	0.0	0	0.0	4	3.0
X^2 P-value	0.032								

No. = Sample respondents.

Feed shortage during the dry season is becoming a serious problem as mobility is restricted due to conflict. According to the herders, the conflict does not only limit the use of available feed resources, but is changing the production system leading to crop production by migrating to more suitable areas for crop production. In addition, camel holding is decreasing due to shrinking browsing areas and animal theft. Some of the suggestions forwarded by the farmers and pastoralists to improve animal production in the area include effective conflict resolution (100% of respondents), improving access to veterinary services (74%), training on feed conservation methods (67%), improving market infrastructure (62%), and introducing improved dairy breeds (29%).

3.9.1 Feed shortage

With regards to change in land use, about 82% of the respondents indicated that grazing lands have been continuously lost to crop production (Table 25). This has resulted due to the continuously increasing human population. This has resulted in overgrazing of natural pastures and land degradation. For these reasons, feed shortage has become a serious problem for animal herders. Feed shortage is critical between May and June as well as between December and February.

As shown in Table 25, the major reasons for feed shortage as indicated by the respondents were lack of rainfall (100%), security problems in accessing rangelands (90%), expansion of croplands (82%) and poor feed conservation practices (43%). Lack of forage seeds (3%) was rated least by the respondents. The major feed resources are natural pasture and crop residues and these are of poor quality affecting milk production and fertility of cows. Ranjhan (1999) also reported that feeding systems in smallholder dairying are primarily based on grazing of native pasture of low productivity. This also agrees with the report

of Leng (1999) who indicated that feed resources from crop residues (straw and stover) and pastures (both green and mature) are of low digestibility; and on these feed resources alone the overall productivity of animals is reduced with delayed age at puberty (often five years), extended calving intervals (often two years), low calving rates (less than 45% of the cows) resulting in a few number of dairy animals being milked at a given time, and low milk yield and short lactation length.

Table 25. *Reasons for feed shortage in different rural* kebeles *in the Mieso district as reported by the respondents*

	Reasons for feed shortage										X^2 P-value
	Poor feed conservation practices		Lack of forage seed		Expansion of cropland		Lack of rain		Security problem		
Rural *kebeles*	No.	%	No.	%	No.	%	No.	%	No.	%	
Dire Kalu	0	0.0	2	13.0	5	33.0	15	100	15	100	
Gena	15	71.4	1	4.8	20	95.0	21	100	18	85.7	
Huse Mendera	11	32.0	0	0.0	29	85.0	34	100	32	94.0	0.034
Hunde Misoma	16	59.0	0	0.0	25	92.5	27	100	20	74.0	
Welda Jejeba	10	43.5	1	4.3	19	82.6	23	100	23	100	
Total	52	43.0	4	3.3	98	81.6	120	100	108	90.0	

No. = Sample respondents.

Strategies used to alleviate feed shortage

Almost all the households in the district face seasonal shortage of feed. Sorghum and maize stover is by far the most important fodder. However, feeding patterns are partly determined by the farming system, the types of crops grown, seasonal availability of feed in the area and opportunities to purchase additional feed and feeding management. During feed shortage, dry season grazing may be replaced by the use of crop residues. For example, about 12% of the respondents purchase stover *(kera),* 82% use *kera* from their own stock and 44% use *Burana* (roots of grasses) (Table 26). Respondents indicated that they use own stover up to the middle of the dry season and then purchase additional feed as required. However, the last measure taken to cope up with feed shortage is either mobility or sale of animals. There has been very little effort to improve utilization of available feed resources in the district.

The availability of crop residues in the dry season is closely related to the stocking system, and /or the type of crop produced (maize or sorghum). Since stover is kept as stalks open in the field (*Kusa)*, farmers are not able to make efficient use of the resource for a longer period. The stocked feed is wasted due to weathering effect and fermentation. Based on visual assessment in the study area, most of the conserved crop residue was left unfed as it had fermented. Since maize stover could not be kept for long, it is used

immediately after harvest. Sorghum stover is preferred as it could be stored for up to six months. For most households, the crop residue (stover) is likely to be finished by the middle of the dry season, and households are forced to either purchase additional feed or move with their animals in search of feed and water.

Table 26. *Variations in copping mechanism for drought and feed shortage among rural* kebeles *in Mieso districts*

Rural *kebeles*	Measures for feed shortage														X^2 P-value
	Raised crop residue		Give feed in small quantity		Purchase crop residues		Use grass root (*burana*)		Sell animal		Mobility		Use cut-and-carry		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Dire Kalu	6	40	4	27	0	0.0	4	27	1	7	15	100	0	0.0	0.00
Gena	15	71	10	48	6	29	6	29	0	0.0	16	76	0	0	
Huse Mendera	31	91	25	74	4	12	20	59	2	6	24	71	1	3	
Hunde Misoma	26	96	25	93	4	15	16	59	1	3	24	89	1	4	
Welda Jejeba	20	87	14	61	0	0.0	7	30	0	0.0	21	91	1	4	
Total	98	82	78	65	14	12	53	44	4	3	100	83	3	3	

No. = Sample respondents.

The two main systems of grazing on communal land in the study area are herding around settlements and herding over long distance. During the dry season, households move with their animals on average 7 km (range from 0.5 to 40 km) in search of feed and water (Table 27). Under these circumstances, conflicts may arise among the Afar, Oromo and Somali ethnic groups due to competition for resources.

Table 27. *Distance travelled in search of feed by households in the different rural* kebeles *in Mieso district*

Rural *kebeles*	Distance travel in search of feed (km)				P value
	No.	Mean ± SE	Minimum	Maximum	
Dire Kalu	15	5.7 ± 0.74	4.00	15.00	
Gena	20	3.8 ± 0.33	2.00	7.00	
Huse Mendera	33	9.3 ± 1.27	1.50	40.00	0.008
Hunde Misoma	26	6.6 ± 1.29	0.50	20.00	
Welda Jejeba	22	6.4 ± 0.73	2.00	16.00	
HH sex[a]					
Female	25	6.2 ± 1.45	0.50	40.00	0.607
Male	91	6.9 ± 0.53	1.00	20.00	
Total	116	6.7 ± 0.51	0.50	40.00	

a. HH sex = Household head sex, SE = Standard error of mean, No. = Sample respondents.

There was significant ($P<0.05$) difference among the rural *kebeles* in the distance herders cover in search of feed and water. The longest distance was recorded for households in Hunde Mendera rural *kebele* (9.3 ± 1.27 km) and the shortest distance was observed in

Gena rural *kebele* (4.0 ± 0.33 km). The short distance covered in Gena rural *kebele* may be due to the fewer number of livestock holdings per household (6.3 ± 0.53). According to the herders in Gena rural *kebele*, the relatively small number of animal holdings and the tribal conflict restrict their mobility and are often forced to make use of purchased feed (29%) or crop residues from their own farm (71%). The other option these farmers have during the dry season is the use of *haya* (mineral soil), and farmers believe that it '*replaces*' the feed requirement of the animals by providing minerals and water. On the other hand, households with relatively large number of animals may have no other option rather than mobility. Similarly, Ahmed et al. (2004) reported that in Afder Zone of Somali Region, camels cover on average 8–10 km away from the homestead in search of feed and water particularly during the dry season depending on the size of the herd. There was no significant difference between female- and male-headed households in the distance herders cover in search of feed and water.

Feeding calendar

Respondents indicated that they use different strategies to overcome feed shortage. Households use different feed resources depending on the season in order to make use of the available feed efficiently. The quantity and quality of feed vary over season and with the type of feeding management. Almost all the households indicated that feeding of pasture on communal land around their encampment is practised at all times. In the dry season, however, they are forced to move to other areas covering up to 40 km. During this period of critical feed shortage, animals may die due to starvation. In livestock specialized systems such as the pastoral systems in southern Ethiopia and Afar Regions, the crop enterprise is not part of the household production unit. The livestock herders are dependent on natural pasture and grazing area and to some extent on grazing crop residues in crop production systems after harvest (Ahmed et al. 2003).

As presented in Table 28, about 98% of respondents indicated that the bulk of sorghum stover is available from November to January. For the period from June to August, 48% of respondents indicated that short growing season maize is available. A relatively smaller proportion of farmers (23.3%) indicated that crop residue is available between February and May. However, seasonal availability and use of crop residue for animal feed in different season differed significantly ($P \leq 0.05$) among rural *kebeles*. About 24% of the respondents in Gena rural *kebele* make use of crop residues all year round, which was higher than in the other rural *kebeles*. This may be due to the fact that these respondents purchase crop residues in addition to using feed from own sources.

Table 28. *Crop residue feeding calendar among rural* kebeles *in the Mieso district based on respondents*

Feeding calendar	Rural *kebeles*										Total	
	Dire Kalu		Gena		Huse Mendera		Hunde Misoma		Welda Jejeba			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All year	0	0.0	5	23.8	3	8.8	1	3.7	0	0.0	9	7.5
Sept–Oct	1	6.7	1	4.8	2	7.4	1	4.3	6	5.0	11	9.2
Nov–Jan	13	86.7	21	100	34	100	27	100	23	100	118	98.1
Feb–May	1	6.7	8	38.0	9	26.5	3	11.1	7	30.4	28	23.3
Jun–Aug	7	46.7	8	38.1	13	38.2	15	55.6	14	60.9	57	47.5
Nov–May	0	0.0	5	23.8	1	2.9	0	0.0	0	0.0	6	5.0

No. = Sample respondents.

Burana is root of grasses taken out from the ground during land preparation or cultivation. It needs a lot of energy to pull out the long branched root from the ground. This type of feed is mostly stall fed to oxen during the cultivation period. However, only 6% of the respondents make use of this type of feed during the long dry season (Table 29). During the dry season, *burana* is also fed to cows and respondents believed that it increases milk yield as its water content is higher than crop residues.

Table 29. *Grass root (*Burana*) feeding calendar among rural* kebeles *in the Mieso district based on respondents*

Feeding calendar	Rural *kebeles*										Total	
	Dire Kalu		Gena		Huse Mendera		Hunde Misoma		Welda Jejeba			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All year	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Dec–Feb	1	6.7	3	14.0	1	2.9	2	7.4	0	0.0	7	5.8
Mar–Apr	15	100	21	100	34	100	27	100	23	100	120	100
May–Jun	2	13.0	9	42.8	4	11.8	2	7.4	1	4.0	18	15.0

No. = Sample respondents.

Chinki (thinnings of maize and/or sorghum) feeding is a major source of feed for livestock. About 74% of the respondents use *chinki* during the short rains season and 93% consider it as one of the most important feed resource during the long rains season (Table 30). This type of feed is used by cut-and-carry system and is primarily fed to early lactating cows and calves. However, maize and sorghum *chinki* is also provided to all classes of livestock in the field, depending up on availability of volume.

Table 30. *Crop thinnings* (chinki) *feeding calendar by respondents in rural* kebeles *of Mieso district*

Feeding calendar	Rural *kebeles*										Total	
	Dire Kalu		Gena		Huse Mendera		Hunde Misoma		Welda Jejeba			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All year	0	0.00	0	0.0	0	0.00	0	0.00	0	0.00	0	0.0
Sep–Oct	1	6.70	3	0.14	2	0.06	0	0.00	0	0.00	6	5.0
Apr–Jun	3	20.0	21	100	23	0.68	22	0.81	20	0.87	89	74.0
Jul–Sept	15	100	21	100	34	100	20	0.74	21	0.91	111	92.5

No. = Sample respondents.

3.9.2 Water resources and management

There are different sources of water for livestock in the district (Table 31). According to the respondents, water sources include rivers (78% of the respondents), springs (65%), ponds (36%), shallow wells (18%), lake (7.5%), and pipe water (5%). However, the availability of these water resources depends on the season and distance from the household. Ruminants require water to maintain their body water content and for metabolism. Availability of water also affects voluntary feed intake (Coppock 1994). Most of the water sources, except pipeline, are found about 1 to 30 km from the households depending on the season. As a result, the seasonal availability and distance of the water sources have implications on the watering frequency of different classes of livestock in the different rural *kebeles*.

Table 31. *Water sources used by the households in different rural* kebeles *in Mieso district*

Type of water sources for livestock	No.	Per cent
River	94	78.0
Well	22	18.0
Lake	9	7.5
Spring water	78	65.0
Pond	43	35.8
Pipeline water	6	5.0

Almost all of the households indicated that watering frequency of cattle were reduced from ‘every day’ watering in the wet season to ‘once in two days’ for 79% of the households in the dry season (Table 32). In the case of camels, about 27% and 18% of the respondents water their camels once a month or not at all in the wet season, respectively. This is due to availability of adequate amount of water in the field during the wet season. However, during the dry season, about 30% of the respondents water their camels once a week and 21% once in three days. Coppock (1994) reported that in Borana there is high degree of water restriction of cattle during the dry seasons and animals may be watered once every three or four days.

Table 32. *Watering frequency of animals in different seasons in Mieso district*

Watering frequency	Wet season				Dry season			
	Cattle		Camel		Cattle		Camel	
	No.	%	No.	%	No.	%	No.	%
Every day	120	100	0	0.0	8	6.7	0	0.0
Once in two days	0	0.0	0	0.0	95	79.0	2	6.0
Once in three days	0	0.0	1	3.0	12	10.0	7	21.0
Once in a week	0	0.0	1	3.0	0	0.0	10	30.0
Once in two weeks	0	0.0	4	2.5	0	0.0	3	9.0
Once a month	0	0.0	9	27.0	0	0.0	0	0.0
Not watered	0	0.0	6	18	0	0.0	0	0.0

No. = Sample respondents.

In addition, respondents indicated that they move with their animals in search of water as means of overcoming water shortage. About 95% of the households move with their animals in search of water, while the rest use the available water source in the area if there is a permanent water source (all season river or pipe water). The overall average distance travelled in search of water was 6.6 ± 0.52 km, and ranged from 1 to 30 km per day (Table 33). The distance travelled varied ($P \leq 0.05$) between rural *kebeles*, and was the longest for Welda Jejeba rural *kebele* (8.0 ± 0.72 km) and the shortest was for Gena rural *kebele* (3.1 ± 0.32 km) due to the availability of the Mieso River in the area.

Table 33. *Distance moved for searching water among rural* kebeles *and by household heads in Mieso district*

Rural *kebeles*	Distance moved for water searching (km/day)				P
	No.	Mean ± SE	Minimum	Maximum	
Dire Kalu	15	7.2 ± 0.74	4	10	
Gena	21	3.1 ± 0.33	1	8	
Huse Mendera	33	7.3 ± 1.27	2	30	0.004
Hunde Misoma	26	7.3 ± 1.29	2	30	
Welda Jejeba	22	7.9 ± 0.73	3	20	
Average	117	6.6 ± 0.52	1	30	

SE = Standard error of mean; No. = Sample respondents.

According to the herders, the consequence of the long distance travelled and the reduced frequency of watering of animals, especially during the dry season, results in loss of body weight and substantial decrease in milk production. Similarly, results from a study on Boran cattle indicated that cattle watered once every three days during the dry seasons lost body weight faster than those on a daily watering frequency. This is because restricted watering reduces forage intake and milk production by about 13% (Coppock 1993).

3.9.3 Animal health care

Diseases pose a major threat to livestock production in Mieso district. The extent of losses due to diseases was very high as compared to losses due to other causes. About 65 and 67% of the respondents indicated that mortality due to diseases was the major cause of loss of cattle and camels, respectively. As presented in Table 34, due to limited veterinary service, almost all the households used traditional treatments, herbs, to treat their sick animals. However, 38% of the households indicated that a combination of traditional as well as veterinary service was used. Traditionally, women drench herbs to sick animals as the male members of the household are responsible for collecting the herbs from the field. Almost all the animal health care rests on the shoulder of women, thus priority should be given in training women in basic animal health care.

Table 34. *Variations on measures taken to treat sick animals in rural* kebeles *of Mieso district*

	Methods for treating sick animals				
	Traditional		Traditional and vet. service		X^2 P-value
Rural *kebeles*	No.	%	No.	%	
Dire Kalu	12	80	3	20	
Gena	11	52	10	48	
Huse Mendera	19	56	15	44	0.002
Hunde Misoma	12	44	15	56	
Welda Jejeba	17	74	6	26	
Total	74	62	46	38	

No. = Sample respondents.

According to the respondents and personal observation in the study area, there is a serious shortage of veterinary experts. There is only one veterinarian and six animal health assistants assigned in the district Office of Pastoral and Rural Development. Generally, shortage of experts, accessibility of veterinary service in the area and lack of adequate transport facility are the major problems. Livestock keepers therefore tend to divert to traditional ethno-veterinary practices in the villages and make use of various herbs and/or use illegal drugs to treat their animals. As a result, a wealth of indigenous knowledge in animal health care is the major means of treating animals in the district. About 53% the respondents indicated that veterinary drugs and services are too expensive while 37% indicated that it is fair. Almost all the respondents (99%) across the rural *kebeles* indicated that they have serious problems in accessing veterinary services. In general, poor animal health service and lack of improved management are the major constraints for dairy development in the district, which caused poor performance across the production systems as also indicated by Ibrahim and Olaloku (2002).

The majority (92%) of respondents indicated that there is no regular visit by veterinarians followed by long distance to the veterinary clinics (65%). Tafesse (2001) reported that the poor performance of veterinary service in the lowlands is the outcome of the government-monopolized service (Table 35). Government veterinary staffs are few in number and cannot cover such a vast area to adequately address the veterinary needs of the livestock keepers. Besides, government staffs do not have adequate transport facilities, and currently the government does not have the capacity to provide veterinary service to all the households (Tafesse 2001). Therefore, training community-based paravets from the community, particularly women, could be an important intervention to ease the animal health problems.

Table 35. *Reasons for poor access to veterinary services in rural* kebeles *of Mieso district*

	Problems related to access to veterinary service								
	Financial problem (for medicine and service)		No regular visit by veterinarian		Long distance to vet service		Shortage of experts		X^2 P-value
Rural *kebeles*	No.	%	No.	%	No.	%	No.	%	
Dire Kalu	1	66.6	10	66.7	13	86.7	4	26.7	
Gena	5	23.8	21	100	10	47.6	12	57.0	
Huse Mendera	2	5.9	32	94.0	20	58.8	21	61.7	0.00
Hunde Misoma	15	55.6	25	92.6	17	62.9	18	66.7	
Welda Jejeba	2	8.6	22	95.6	18	78.0	15	65.0	
HH sex[a]									
Female	5	18.5	23	85.0	19	70.0	15	55.6	0.186
Male	20	21.5	87	93.5	59	63.0	55	59.0	
Total	25	20.8	110	91.7	78	65.0	70	58.0	

a. HH sex = Household head sex; No. = Sample respondents.

According to the respondents, mastitis (45.8%), anthrax (20.8%), pasturolosis (15%), diarrhoea (9%), Blackleg (7.5%), and FMD (5%) were the major diseases that affect cattle (Table 36). A high incidence of clinical mastitis in milking cows was observed during the course of the study. Although not determined by this study, there may as well be a high incidence of subclinical mastitis cases. This disease has received little attention so far. This disease is an economically critical disease in milking cows as it causes financial loss as a result of decreased milk yield (Morse et al. 1988). Due to limited veterinary service in the study area, the only means of treating mastitic animals were use of different traditional

treatment methods such as branding, adding of salt after cutting the infected part, herbs like *harmel* (nods or root), *wato* (leaves), *harinio* (leaves), *Buri* (red root), and *kenkelcha* (leaves).

Table 36. *Response on major diseases that affect cattle in Mieso district*

Types of diseases	Rural *kebeles*										Overall HH (No.)	
	Dire Kalu		Gena		Huse Mendera		Hunde Misoma		Welda Jejeba			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Anthrax	3	20	4	19	6	17.6	7	25.9	7	30.0	25	20.8
Pasturolosis	4	27	3	14	4	11.7	5	18.5	2	8.6	18	15.0
Blackleg	2	13	2	9.5	1	2.9	3	11.0	1	4.3	9	7.5
FMD	2	13	1	4.7	2	5.8	0	0.0	1	4.3	6	5.0
Mastitis	3	20	11	52.0	20	58.8	12	44	14	60.9	55	45.8
Diarrhoea	2	13	5	23.8	2	5.9	0	0.0	2	8.6	11	9.0
Tick infestation	4	26.6	2	9.5	9	26.0	5	18.5	4	17.0	2	1.7
X^2 P-value		0.016										

HH = household, FMD = Foot-and-Mouth-Diseases, No. = Sample respondents.

3.9.4 Breeds of dairy animals

All animals used for milk production (cattle, camels and goats) in the district are indigenous breeds. The cattle breeds are zebu types and have not been characterized. Most of the respondents prefer local cows claiming that crossbred animals are susceptible to diseases and will not withstand feed and water shortage. As a result, there has been no crossbreeding of local cows with exotic dairy breeds in the district. IPS (2000) indicated that the genetic make up of Ethiopia's lowland livestock have evolved largely as a result of natural selection influenced by environmental factors. This has made the stock better conditioned to withstand feed and water shortages, disease challenges and the harsh climatic conditions in the area. Bulls commonly run with cows all year round and breeding is thus uncontrolled. As cattle herders do not use control breeding, the reproduction of their cattle is primarily regulated by seasonal feed availability.

3.10 Institutional support to dairy production

Both governmental and non-governmental organizations operate in the study area. However, most of the non-governmental organizations, except the IPMS project of ILRI (International Livestock Research Institute), IRC (International Rescue Committee), and Mercy-corps, are not involved in animal production. Mercy-corps operates jointly with the *woreda* Office of Pastoral and Rural Development (OoPRD) by providing improved

forages to farmers and drugs and vaccines for type B diseases. IRC develops water resources through establishment of pipeline water from underground water resources and water harvesting ponds with a plastic sheet (locally known as *Haro*). The IPMS project's contributions in the livestock sector include knowledge management, capacity development, commodity development using value chain approach and research in dairy, small ruminants and cattle fattening. These activities are being implemented in collaboration with all the departments in the OoPRD.

From the government side, safety net program helps the community through micro-credit for small livestock production such as poultry and goat production. The program targets marginal and poor members of the community and provides support to dairy goat production. Moreover, all departments in the OoPRD support farmers and pastoralists by creating access to purchasing inputs such as drugs and vaccines. However, these efforts are not proportional to the size of the district and the huge livestock population.

About 49% of the respondents indicated that they get support from the government in the form of consultation and training on cooperative establishment, feed resources development and resource allocation. However, in case of extension support on dairy animal production, 33% of the respondents indicated that they get consultations from the extension agents once or twice a year without a strong and regular visit. For example, very few farmers (8%) in the study area have been exposed to improved forage cultivation. The largest number of farmers that have planted forages in their farm yard are only 18.5% of those in Hunde Misoma rural *kebele*. However, all farmers interviewed were not aware of the availability and importance of improved forages. According to the observation in the study area, some households have planted improved forages, but do not have any knowledge on their utilization. Limitation in the number and capacity of the development agents was also found to be a common problem in the extension service.

The IPMS project has provided training and consultation support on milk collection and marketing system through establishing marketing cooperatives, especially with the existing women milk marketing group (*Faraqa Annanni*). During the interviews, some producers mentioned bad previous experience with producer cooperatives during the Dergue regime that they do not have full trust in cooperative establishment. Therefore, there is need to break down the complexity of the existing situation so that the community could start to establish milk marketing cooperatives to benefit from collective marketing, input supply and other service provision.

4 Conclusion and recommendations

The major technical constraints to dairy production in Mieso district were feed scarcity, water shortage, poor veterinary service and limited access to markets. The contribution of milk production and marketing depends largely on assured supply of accompanying inputs such as feed, veterinary drugs and improved milk marketing facilities. This study showed that there is a large potential for dairy development in the *woreda*. However, the following areas need attention if dairy production is to develop into a market-oriented business operation in the district.

- Improve available natural pasture and introduce haymaking.
- Develop and implement appropriate rangeland management systems.
- Introduce and develop improved forages as sole crops or integrated with cereal crop production (sorghum or maize system).
- Improve sorghum and maize stover conservation and enhance utilization by chopping, and treating with urea molasses.
- Consider the possibility of selection and crossbreeding for dairy production in locations where it is feasible with improved feeding, health care and proper management systems.
- Improve animal health services including paravet training and drug supply system with close monitoring and supervision.
- Strengthen community diseases surveillance and reporting system.
- Establish milk collecting and processing unit through encouraging the already existing self-organized group *'Faraqa Annanni'*.
- Introduce technologies for the processing of goats and camel milk.
- Develop market linkage between producer and consumer for milk and milk products.
- Examine the possibility of credit provision for improved dairy production, processing and marketing.
- Train district staff, development agents and farmers/pastoralists (mainly women) in dairy production, processing and marketing.
- Seriously deal with conflicts over resources in the district.

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